LIPOPROTEINS

A DISCUSSION on lipoproteins, organised by the Colloid and Biophysics Committee of the Faraday Society, was held in the Department of Pharmacology of the Medical School of the University of Birmingham during August 29–31, 1949. Prof. E. K. Rideal, who was in the chair at the opening meeting, said that this Committee, which has been in existence for a good many years, was originally due to the initiative of Sir William Hardy, and was intended to provide a bridge between the simpler systems with which colloid chemistry was then mostly concerned and the properties of living matter.

However tenuous the bridge may have been in earlier days, it is now a robust structure which carries a good deal of traffic in both directions. The Faraday Society has recognized the coming-of-age of this approach to living systems by revising the terms of reference of the Committee so that it now covers biophysics as well as the applications of physical chemistry to biology. The Committee consists of three representatives of the Faraday Society, with a number of representatives of other biological, chemical and physical societies having an interest in this field. During the past twenty years the old Colloid Committee had been responsible for one discussion meeting every two years on various topics usually having a biophysical flavour. The new Committee, however, will now have the responsibility of organising a discussion every year, the present one on lipoproteins being the first. In addition, informal half-day meetings on special topics, such as the one recently organised by Dr. R. K. Schofield at Rothamsted, are being arranged.

The meeting on lipoproteins fell into three parts. The first was concerned with the nature of the interaction between proteins on one hand and fatty acids and similar compounds on the other. A number of techniques were described which are used to investigate these interactions. Dr. J. H. Schulman and Drs. P. Doty and R. Matalon described monolayer techniques of investigating the interaction of proteins with fatty acid monolayers. Prof. Murray Luck described the investigation of the binding of fatty acid anions by measurements of the equilibrium between the inside and outside of a dialysis bag containing the protein. It is interesting to find that serum albumin, which probably functions as a lipid transporter, is in a class by itself in its combining capacity for fatty acid anions and is able to bind about twenty-five ions per molecule. Dr. K. G. A. Pankhurst has investigated the interaction of gelatine with detergent ions, and finds that the penetrability of gelatine depends on the cross-section of the anion. Prof. D. G. Dervichian discussed the nature of protein-lipid interaction.

Discussion on these topics revealed a considerable divergence of views on the nature of the combination. Are protein-lipid complexes stoichiometrical compounds; or micelles of fat covered with a layer of protein; or protein molecules surrounded by layers of lipid? What are the forces uniting the fatty acid anion with the protein? The main conclusion from the discussion seemed to be that proteins vary greatly in their reaction with lipids. The synthetic protein–fat mixtures do not necessarily give any very close clues to the nature of the natural protein–lipid complexes, in which the protein may be specially adapted to its function of combining with lipids.

The second part of the discussion was concerned with the natural fat-protein complexes of blood. Prof. D. Macheboeuf and Dr. P. Rebeyrotte described their work on a lipoprotein obtained by acid precipitation of horse serum. Dr. A. S. McFarlane discussed ultracentrifugal and electrophoretic experiments on the state of lipids in blood plasma. Drs. G. Popják and E. F. McCarthy described measurements which show that the lipids present do not contribute to the osmotic pressure of serum. Miss Mary Pangbourne discussed the difficult problems of the role of lipids in serology and in immunological reactions. Prof. A. C. Frazer gave an account of his work on the absorption of fats. His view is that fat digestion in the intestine is very incomplete, and that neutral fat is absorbed as such in the form of minute emulsified particles of size less than $0 \cdot 5 \mu$ in diameter, which can be detected in the blood under dark-ground illumination. These are absorbed via the lacteals, while the soluble fatty acid–bile acid complexes pass directly from the intestine into the portal blood.

Another approach to the question is provided by the work of the Physical Chemistry Laboratory of the Harvard Medical School on the fractionating of the blood proteins, which was described by Prof. E. J. Cohn and Dr. J. T. Edsall. This has resulted in the isolation and characterization of two quite distinct lipoproteins. The α-lipoprotein, which is associated with the albumin fractions, but is a fairly minor constituent of the serum, consists of about 65 per cent protein and 35 per cent lipid materials, and has a molecular weight of 200,000. The β-lipoprotein, which is associated with the globulins, accounts for three-quarters of the lipid of fasting human plasma. It is a very complex substance containing 25 per cent protein, 30 per cent phospholipid and 45 per cent of cholesterol. A spherical particle of molecular weight 1,300,000, it is obviously of great significance for the transport of fats in the blood.

The third part of the symposium was concerned with lipoproteins in cell structures. This became necessarily a review of isolated observations of separate phenomena, since so little is known. Prof. A. Claude gave a much appreciated lecture on his work on separating the cell particles of different sizes by means of differential centrifugation. The larger particles, the mitochondria, are usually about 2μ long and $0 \cdot 4 \mu$ in diameter, and therefore have a dry weight of $1 \cdot 4 \times 10^{-7} \gamma$, which corresponds to something of the order of 1,000,000 protein molecules. They contain 25 per cent of lipids and 8–10 per cent of ribonucleic acid. Since it has been found that the oxidizing enzyme systems of the cell are concentrated in these particles, they are probably very much concerned with the utilization of energy in the cell and the oxidation of fats. The smaller particles, the microsomes, which account for 50 per cent of the dry weight of the cell, have been found to contribute very little enzyme activity.

Prof. E. Chargaff discussed a number of types of lipoproteins taken from animals (for example, lipovitellin from the yolk of hens' eggs, and the thromboplastic protein of lungs) as well as those contained in the chloroplasts and chromoplasts of plants, which contain a very high content of lipids. Prof. A. Frey-Wyssling described his studies of chloroplasts, and Drs. J. Elkes and J. B. Finean gave an account of the changes of X-ray diffraction pattern caused by drying the sciatic nerve of frogs.

It was inevitable in a field which is at such an early stage of exploration that the subjects discussed lack coherence, but it was clear to everybody that large territories are awaiting exploration, and the work so far done barely scratches the surface. The whole discussion served to bring together those who have been working on these complex biological materials, with the physical chemists whose work has hitherto been largely confined to simple systems. It was apparent that the work done in isolating natural lipoproteins and fat-containing particles provides a practical starting point for investigations in which the precise methods of the latter are applied to substances of direct biological importance.

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ACOUSTICS OF ROOMS

AT this critical period of post-war reconstruction, the problems of architectural design are rising with special acuteness, accentuated by new methods of building construction and limited material resources. One of the most pressing of these problems is the fulfilment of acoustic requirements in committee and lecture rooms, studios, theatres and concert halls. The importance of acoustic design is reflected in the increasing interest in acoustical research and in the growing demand for instruction in acoustics in the schools of architecture. The importance of the subject is equalled by its difficulty. It is the meeting-ground of art and mathematics, of psycho-physical and physical studies. Even on its objective side it is highly complex and resistant to analysis.

The Acoustics Group of the Physical Society is therefore to be congratulated for arranging the course of six lectures on room acoustics which were given in the Royal Institution by Dr. Richard H. Bolt, director of the Acoustics Laboratory of the Massachusetts Institute of Technology and president of the Acoustical Society of America. These lectures, supplemented by three colloquia, presented to British architects and acoustic engineers a summary of accepted theory, a report of recent progress, and a review of problems requiring further investigation.

The course opened with a discussion of the classical theory of W. C. Sabine and A. Jaeger. This theory was based on the assumption of uniform diffusion of sound energy in the room. It predicts an exactly exponential decay of sound energy with a definite value of reverberation time which is inversely proportional to the total sound absorption of the air boundaries. Using modern methods of sound recording, it is easily shown that the assumption of uniform diffusion is, in general, not in accordance with facts, for variations in sound-level are observed when a non-directional microphone is used at different points in the room or when a directional microphone is used in different orientations about a fixed point. The experimental decay curve usually shows fluctuations, and when these are smoothed out, the resulting curve is not strictly exponential, the rate of decay decreasing with time. Serious departures from theory may be observed when the reverberation method is used for measuring the absorption coefficients of acoustic absorbents, for even when diffraction effects are kept small, the measured values of absorption depend not only on the particular room used, but also on the position and orientation of the tested sample. Nevertheless, the conditions assumed by Sabine are the ideal conditions for room acoustics, and recent work has been directed towards discovering the means of attaining them.

A wave theory is required to give a complete account of the phenomena. The primitive conceptions are still simple. The air in the room has a large number of normal modes of vibration, each having a characteristic natural frequency. The wave equation is separable in the co-ordinate systems appropriate for a number of shapes of air space, and the corresponding normal mode solutions for rigid and for slightly absorbing walls are obtainable in a straightforward manner. When a steady source of sound is used, forced vibrations of the wave states take place, and transient free vibrations are excited by starting and stopping the sound. Photographs due to Knudsen[1] were displayed showing the transients excited by stopping a single-frequency source.

The wave theory for the case of a rectangular room with slightly absorbing walls was treated in some detail. Here the normal modes are a system of plane waves, and the natural frequencies can be represented by a lattice of points in the first octant of a three-dimensional frequency-space. The vectors representing the points have a magnitude proportional to the frequency and a direction parallel to the wave normal. The lattice is the basis of calculations of the number of normal modes of any type having frequencies between given limits[2]. The chief types are the oblique, tangential and axial modes, and these have characteristically different damping constants and energies per unit amplitude. The oblique waves have the greatest and the axial waves the least rates of decay. The shape of the smoothed reverberation–time curve is thus explained. It follows that, in such a rectangular room, strictly exponential decay cannot be obtained even for high-frequency sound.

The statistics of the eigen states of rectangular rooms were examined by Dr. Bolt in terms of fluctuation parameters, and the treatment was made more general by the use of non-dimensional frequency and room-shape variables. The smoothness of the frequency response was expressed by using ρ, the ratio of the actual spacing to the average spacing of the frequencies. The second moment of ρ gives a measure of smoothness. Diagrams were shown giving the relation between smoothness and room shape[3].

Up to the 'critical range' from the source, the energy density is predominantly due to direct radiation, and beyond this range the sound field is incoherent. The statistical properties of the incoherent field of a steady source have been studied by varying the frequency[4] or by varying the position of the microphone[2], and the results give respectively the 'transmission irregularity' and the 'space irregularity'. Satisfactory agreement has been obtained between theoretical and experimental values for the first of these parameters, and one or both of them may, in the future, prove to be convenient means of estimating the diffuseness of the sound field.

The course included a short account of the relation between the damping constants of the normal modes and the specific normal impedance of the walls, and also a discussion of the dependance of normal impedance on the porosity and flexibility of the wall. The theoretical energy losses at the wall expressed in terms of viscous and heat losses do not account for the total loss observed experimentally. In certain