mediate states of the bacteriorhodopsin can be detected by laser resonance Raman spectroscopy. These are invoved in the cyclical association and dissociation of protons with the retinylidene–lysine linkage, a Schiff base which seems to crank the proton pump. Stoeckenius also illustrated an exciting foretaste of the work of R. Henderson and P. N. T. Unwin (MRC, Cambridge) who have made a brilliant application of new electron microscopy techniques to provide a 7 Å electron density profile of the bacteriorhodopsin lattice, projected on to the plane of the membrane. The projection indicates a number of helices perpendicular to the plane of the membrane and apparently spanning the bilayer, and is surely a sign of much more to come. Taken together these studies suggest that the purple membrane will be the first for which a detailed structural model will accommodate a specific functional protein.

Another membrane fraction enriched with a lattice-like array of protein molecules is obtained from the excitable membrane of *Electrophorus electricus*. New evidence was presented by J.-P. Changeux (Pasteur Institute, Paris) that the nicotinic receptor lattice can be transformed into a desensitised state by calcium, local anaesthetics, and changes in the lipid environment of the protein, in which it has a much higher affinity for acetylcholine than in the functional state. R. W. Eastabrook (University of Texas, Dallas) also showed that the P450 cytochrome molecules in microsomal membranes form clusters, which exist as a persistent entity with a fluid lipid bilayer. A working hypothesis for the activation of adenyl cyclase by cholera toxin (P. Cuatrecasas, Johns Hopkins University), involves the formation of an inactive complex of toxin with the ganglioside receptor, which subsequently migrates laterally in the plane of the membrane to form patches of the complex. It is then transformed into an active species by dissociation of the hydrophobic subunit of the toxin into the bilayer, which directly activates the cyclase (virtually irreversibly).

This raises the more general question of the trans-membrane coupling of hormone receptors on the outer surface of the membrane with the adenyl cyclase moiety on the inner surface: do they migrate independently in the two halves of the bilayer when uncoupled until the hormone provides the signal for a locking interaction, or is the receptor always associated with the enzyme as a multicomponent entity? This is clearly susceptible to biochemical analysis, but the difficulty in placing constraints on molecular models from a purely functional analysis of membrane phenomena was well illustrated by R. D. Keynes (University of Cambridge), who described some elegant experiments on the gating current in squid axons. The initial opening of the sodium channels in the conduction of the action potential is brought about by the movement in the electric field of a group of charged gating particles of which there are three per channel, and the subsequent relaxation to the impermeable state apparently occurs by a time-dependent conformation change. The importance of direct biochemical evidence for structural properties of membrane proteins was emphasised in a review of the transport of metabolites by vesicles from *E. coli* by H. R. Kabach (Roche Institute, New Jersey) which included the striking result that the *lac* carrier protein is inaccessible to fluorescent inhibitors of lactose transport in the external solvent in the absence of energy coupling, but on generation of a membrane potential, binding of dansyl galactosides is observed. Alternatively binding can be induced by lactose efflux through the carrier and down a concentration gradient.

In addition to these features of the structure and function of the membrane proteins, the asymmetric distribution of the lipids in the bilayer is now firmly established. The biochemical approach of using pure phospholipase to digest selectively the lipids in the inner and outer halves of the erythrocyte bilayer has worked surprisingly well in Van Deenen's group (University of Utrecht), and there is a good qualitative agreement with the previous chemical labelling techniques of Bretscher. It seems that in many plasma membranes the lipids with choline headgroups are predominantly located in the outer half of the bilayer. Wisnieski *et al.* (*Proc. natn. Acad. Sci. U.S.A.*, **71**, 4381; 1974) have recently suggested that transport proteins in mammalian cytoplasmic membranes sense independent lateral phase separations of lipids in the inner and outer halves of the bilayer, which presumably requires an asymmetric lipid distribution.

To the prejudiced outsider, the mitochondrion has long seemed like the Boot Hill of the membrane field. But as the plethora of undefined mitochondrial factors, described in another context by Bangham as "more like a culinary extravaganza than a scientific experiment", have given way to biochemical studies of isolated proteins and functional complexes reconstituted from defined components, the functional relationships between components can be defined much more precisely. A powerful assault on the function and disposition of the seven polypeptides of cytochrome oxidase from yeast by immunological and genetic techniques was summarised by G. Schatz (Biozentrum, Basel). The three largest polypeptides are synthesised in the mitochondrion, and two of these are hydrophobic and relatively inaccessible in the 'core' of the enzyme. But the catalytic activity of the enzyme requires subunits which are synthesised in both the mitochondrion and the cytoplasm, which presents a very interesting problem in the biosynthetic integration of the complex structure. M. Klingenberg (Universitat Munchen) described his elegant work on the purification of the ADP/ATP carrier in mitochondria, using inhibitor protection to hold together the two subunits of molecular weight 30,000. In the intact membrane it was shown that the protein functions as a gated pore rather than a rotating mobile carrier and is structurally asymmetric.

The relationships between ion fluxes and solute transport which can be generated by mitochondria are sufficiently complicated that as G. F. Azzone (University of Padua) remarked after discussion of cation extrusion processes, it is still impossible to be dogmatic about opposing theories of the coupling between metabolism and transport. Nevertheless the groundswell has been moving strongly in favour of Mitchell's chemiosmotic hypothesis for several years, and in other systems the evidence seems relatively clear-cut. M. Avron (Weizmann Institute, Rehovot) discussed the light-dependent formation of ATP by chloroplasts, and showed that photophosphorylation is a linear function of the proton concentration gradient within a small range of *p*H across the membrane, and that no phosphorylation can be observed below a critical threshold. This explains the lag in the time course of phosphorylation at very low light intensities, but surprisingly, neither the threshold nor the linear dependence varies signifi-

A hundred years ago

A NEW steering balloon by Smitter is being exhibited, suspended in the middle of the Alcazar in Paris. The measurement is only 6,000 cubic feet, but the balloon is so light, that when filled with pure hydrogen it must float. A considerable sum of money has been invested in it, and great ability has been displayed in the construction. Although no practicable result in open air may be hoped for, it is a wonderful piece of clockwork.
from *Nature*, **12**, 153; June 24, 1875