as a probe for the mobility of the β-adrenergic receptor in the presence and absence of microfilament-disrupting drugs and conclude that the receptor is anchored to the cytoskeleton.

A steady improvement in the quality of 'model' membranes is taking place at the same time as the successful extraction and characterization of intrinsic membrane proteins. M. Montal (University of California) has developed a technique of spreading two monolayers of protein and lipid and apposing them across an aperture to form a planar bilayer. H. Schindler (University of Basel) employs the same technology, but has discovered that natural membrane or lipid vesicles, added to the aqueous compartments, are in equilibrium with and contribute representative lipids and proteins to the surface monolayers.

The functional reconstitution of membrane proteins will allow two persistant problems to be addressed. First, what, if any, is the influence of particular lipids on protein function? and second, what role is played by protein–protein interaction in the bilayer? P.F. Devaux (Pasteur Institute, Paris) has devised spin-labelled lipid probes which covalently attach via their head groups to reconstituted membrane proteins. This achieves a significant increase in occupancy by probe of the protein–lipid boundary. Rotational correlation times of the proteins obtained in this way indicate strong lateral interactions (protein–protein) for ACh receptor and Ca^{2+}-ATPase and very weak ones for rhodopsin. Spin exchange between boundary probe and lipids spin-labelled with a different nitrogen isotope show that migration of lipids into the lipid boundary of rhodopsin is independent of the head group.

Lateral interactions between the intrinsic membrane proteins of the inner mitochondrial membrane were explored by C.R. Hackenbrock (University of North Carolina). Electron transfer between the various oxidation–reduction complexes and carriers appears to be facilitated by the gregarious nature of the proteins. However, although electron transfer decreases monotonically with the addition, by fusion, of exogenous lipid, it does not cease. Freeze-fracture of vesicles reveals uniform dispersion of all particles (proteins) in lipid-enriched membrane vesicles. Antibody marker techniques demonstrate that cytochromes oxidase, *b* and *c* do not migrate as complexes. In fact, sufficient diffusional motion (measured by freeze-fracture of vesicles after relaxation of an electric field) of the intrinsic proteins can occur within one turnover of reducing equivalents to render stable protein–protein interactions unnecessary.

Another role hypothetically associated with lateral interactions of intrinsic membrane proteins is the formation of an ion pore/channel in response to an associating stimulus. Montal and Borochov-Neori (University of California) examined whether vertebrate rhodopsin mediates changes in membrane ion permeability by aggregation following the light-dependent conformational change of the molecule. Conductance characteristics of planar bilayers containing rhodopsin support this view of channel formation. However, the alteration in aggregation state after bleaching (determined by fluorescence-energy transfer between rhodopsin monomers) is more subtle than expected.

Cast in the role of principal information carrier associated with the operation of membrane channels, ionic calcium continues to attract much attention. The eager studies of the action of intracellular calcium have often overshadowed the more sober, but hardly less important, investigation of its intracellular regulation. Although there is still confusion and controversy about how calcium enters the cytoplasm, steady progress has taken place in measuring it when it is there and on how it is removed to return the cell to a resting state. For example, using permeant fluorescent calcium indicators synthesized by R.Y. Tsien (University of Cambridge), resting lymphocyte calcium ion was measured at 0.12 μM.

For the extrusion of calcium ions, two plasma-membrane processes are available: a Na^+/Ca^{2+} exchange protein and a calcium-stimulated ATPase. Blaustein and Nelson (University of Maryland), DiPoldo and Beauge (Caracas and Cordoba, Argentina) and Caroni and Carafoli (University of Zurich) all described a calcium removal process operating at very low levels of Ca^{2+} (down to 0.1μM), fueled by ATP. However at high Ca^{2+} (up to 10 μM), Na^+/Ca^{2+} exchange was dominant. The latter authors reported that the cardiac muscle sarcolemma Na^+/Ca^{2+} exchanger swops $3Na^+$ for 1 Ca^{2+} (requiring a counterion) and is insensitive to calmodulin, unlike the Ca^{2+}-ATPase.

High intracellular Ca^{2+} was formerly thought to regulate the permeability of the intercellular gap junction. As related by M.V.L. Bennett (State University of New York), the association constant for this process is unphysiologically high (K = 0.4mM Ca^{2+}). In single pairs of embryo blastomeres connected by gap junctions, conductance is regulated by a process with a pK_a of 7.3 (the channels are closed when the cytoplasm is slightly acidic). Voltage clamping the cells at different levels, thus forcing a transjunctional potential, also closes the channels. These two control processes are not the same, since aldehydes selectively block the *p*H dependence.

Work on the mammalian liver cell gap junction has also progressed well; a hexameric array of protein units spans the

100 years ago

POPULAR NATURAL HISTORY

We give, through the courtesy of the publishers, another illustration taken from the chapter on Weevils. It is of a weevil known as *Rhyncophorus palmarum*. Its fat grubs live on the stems of palm-trees, and are often very destructive. Several of the species are very injurious to the sugar-cane. One found in sugar-plantations in Guiana contain in their intestines lumps of a sweet waxy substance — the altered saccharine food on which they live — and for this they are boiled and eaten by the native. The fine fat larva and the pupal condition, as well as the full-grown weevil, are to be seen in the engraving.

From *Nature* **25**, 109, December 1, 1881.

0028-0836/81/490401-02$01.00