Potassium concentration and potential difference in the single isolated electroplax of the electric eel*

There is good evidence that the potential difference (p.d.) across living membranes may be attributed essentially to the unequal distribution of K^+ ions. Due to some properties responsible for the specific permeability to K^+, the p.d. follows the well-known Nernst relation. But since living membranes (as well as artificial membranes) are never perfect selective membranes, the p.d. actually measured shows sometimes a discrepancy with that predicted by the Nernst relation. This reflects the importance of other ions moving passively. The greater the discrepancy the less specific is the membrane toward K^+ only. Then the Nernst relation holds only if we replace the other diffusible ions by nondiffusible ones, for instance Cl^- by SO_4^{2-} (*cf.* for instance USSING *et al.*[1]).

Most studies about the effect of the outside K^+ concentration on the p.d. across living membranes has been done on muscle fibers[2], nerve fibers [3], frog's skin[1] and on the electroplax of electric eel[4]. In the latter case, however, the results reported have no bearing on the problem because the electroplax is formed by two membranes completely different in structure and function, and the type of preparation used excludes for various reasons a proper evaluation.

Recently a technique has been developed that allows the study of both membranes separately[5-7]. A single isolated electroplax is placed between two pools of fluid in such a way that one pool of fluid is in contact exclusively with the innervated membrane, the other pool exclusively with the non-innervated membrane. The effect of various concentrations of K^+ on the p.d. has been studied when applied exclusively either to one or to the other of the two membranes. It has been found that at concentrations of K^+ ranging from 0.5 to 50 mmoles (normal value, 5 mmoles) the line relating the p.d. across the non-innervated membrane to the log of its outside K^+ concentration has a slope varying between 20 and 40 mV.

In contrast, when the effects of the K^+ concentration in the fluid bathing the innervated membrane were studied, there was a small effect on the p.d. Sometimes, a 10-fold increase in the outside K^+ concentration decreases the p.d. of the innervated membrane by a few mV only. In one case, after contact for 2 h with a 50 m*M* solution of K^+ bathing the innervated membrane, the p.d. has been found to be reduced by 20 mV. On the average, the results showed a change of around 5 mV for a 10-fold change in concentration of K^+.

The effect of the outside K^+ concentration thus differs markedly between the two types of membrane tested. The straight lines relating the p.d. as a function of the log of the outside K^+ concentration in the two pools of fluid have two different slopes. Therefore, we must assume that the permeability properties of the non-innervated and the innervated membranes are different. The permeability of the non-innervated membrane to K^+ seems to be more specific than that of the innervated membrane. But since the p.d. does not exactly follow the Nernst relation, this deviation indicates that the membrane is appreciably permeable also to other ions. Na^+ and small organic anions (amino acids, for instance) appear to be the most probable ions which may "short circuit" the p.d. resulting from the unequal distribution of K^+. Cl^- does not seem to contribute to the p.d. since SO_4^{2-}-saline does not affect the resting potential.

The small effect of the outside K^+ concentration on the p.d. of the innervated membrane, appears interesting and requires an explanation. Two possibilities, open to experimental test may account for the difference observed: the permeability of the innervated membrane to other ions than K^+ may be much greater than that of the non-innervated membrane, or the innervated membrane may be much less permeable to K^+ than the non-innervated. Experiments are being prepared to decide between these alternatives.

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