Temperature Effects on Renal Membrane Ionic Permeability

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Dear Sir,

The proper functioning of renal cell membranes is essential for the maintenance of ionic homeostasis, and processes which alter membrane activity are manifested by significant changes in systemic electrolyte imbalances. In this study, the effects of temperature on ionic permeability were examined in purified renal membranes.

Rabbit renal brush border membranes were obtained through a series of homogenation and differential centri-fugations steps. Membrane voltage measurements were made using the potential sensitive dye 3,3-dipropylthio-dicarbocyanine iodide [diS-C₃-(5)]. Relative ion permeabilities were derived from membrane potentials and the constant field equation.

Estimations of absolute ion permeabilities were made by observing the time course of membrane potential decay under well-controlled ionic conditions [1]. Fluorescence measurements were made using a Fluorolog II spectrophotometer regulated using a circulating water bath. The estimated ion permeability of Cl⁻ at various temperatures is presented in table I. In the temperature range examined (25–55 °C), the maximum permeability was found at 40 °C, consistent with synthetic lipid membranes where a maximum permeability is at the phase transition. Like synthetic membranes, purified renal vesicles demonstrate a linear relationship between Cl⁻ permeability and temperature which is independent of the peak at 40 °C [2]. The relative ion permeabilities of five anions were examined at 25 and 55 °C. At 25 °C there is a distinct permeation sequence, F⁻ (0.4 ± 0.1) < Cl⁻ (1.0 ± 0.2) < NO₃⁻ (1.9 ± 0.2) < Br⁻ (2.6 ± 0.3) < I⁻ (2.6 ± 4), which corresponds to a positively charged pore with weak field strength [1]. At 55 °C the same sequence was observed; however, the relative permeabilities of NO₃⁻, Br⁻ and I⁻ were significantly lower relative to Cl⁻, F⁻ (0.2 ± 0.1) < Cl⁻ (1.0 ± 0.2) < NO₃⁻ (1.3 ± 0.3) < Br (1.6 ± 0.3) < I⁻ (18 ± 2).

Table 1. Cl⁻ permeability of purified renal membrane vesicles

It is of significant interest that the ionic permeability of renal membranes demonstrates a response to temperature similar to that seen in synthetic lipid membranes. However, when multiple anion permeabilities were examined, a distinct relationship between temperature and individual permeation rates was observed, probably reflecting the multiple ion pathways in renal tubule membranes.

References

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