Dielectric Measurements on Gramicidin-Lysolecithin Micelles.

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Ion transport through Gramicidin channels in lipid membranes is thought to occur by a mechanism which involves at least three elementary steps: entry of the ion into the channel, ion translocation from one (or several) binding sites near one end of the channel to the other end of the channel, and exit. Each of these steps is characterized by a rate constant. A knowledge of the rates allows the transport properties of the channel to be predicted (1). The rate constants involved with entry and exit of the ions were recently determined by means of NMR-techniques, using Malonyl Gramicidin containing lysolecithin micelles (1).

Here, we report dielectric measurements on the same system aimed at a determination of the ion translocation rate. Since translocation of ions across the channel causes a large change in dipole moment of the micelle, it is expected that this step can be identified in the dielectric relaxation spectrum.

The complex permittivity of micellar solutions was determined in the frequency range .005 to 900 MHz. Both pure lysolecithin micelles as well as mixed Malonyl Gramicidin - lysolecithin micelles were used. Either LiCl, or NaCl, or Tl-acetate was added at 10 mM concentration. In the mixed micelles the Malonyl Gramicidin reached a final concentration of 8.7 mM. All the relaxation spectra showed dispersion regions below 100 kHz (due to electrode polarization), and at 100 MHz. The spectral region in between is characterized by a monotonic decrease except for the combination of Tl-acetate and mixed Gramicidin-lysolecithin micelles. This combination displayed an additional feature which could be modelled by a Cole-Cole term with $\Delta\varepsilon' = 30$ and a relaxation time between 120 nsec (at 25°C) and 36 nsec (at 55°C). This combination was the only one which contained channels predominately occupied by a single ion at the salt concentrations used. Thus, it is very likely, that the observed dispersion represents dipole changes associated with the ion-channel complex. The dipole changes, then, may represent ion transfer through the channel at a rate of approximately 10^7 sec^{-1}, or else, rotation of the ion occupied micelles.

(1) Urry, D.W., Venkatachalam, C.M., Spisni, A., Bradley, R.J., Trapane, T.L., and Prasad, N.U., (1980), J. Membr. Biol. 55, 29.