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The space constant for glial potassium buffering in the isolated frog brain

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In frog brain the surface negativity induced by raised surface K^+ concentration is similar in magnitude to that in the rat brain, but develops *ca.* 10 times faster, with a half-time of 1–2 s (Gardner-Medwin, 1983). These potentials are indicative of cellular K^+ transfer, largely through glial cells, by the 'spatial buffer' mechanism. It therefore appears that, in the frog, K^+ rapidly diffuses to affect glial membranes with a total conductance equal to the input resistance of the glial network. The glial network might have a short electrotonic space constant ($< ca.$ 60 μm, cf. 200 μm in rat brain), or there might be a specialized region with high glial membrane conductance at the tissue surface, as in retinal Müller cells (Newman, 1984).

The electrotonic space constant of the cells carrying current in this situation can be inferred from the pattern of outward current, and consequent extracellular current, early after a sudden solution change. The depolarizing influence and inward current are then necessarily restricted to a zone close to the surface. The depth dependence and time course of the extracellular voltage changes induced by surface solution changes from 2·5 to 17·5 mM-K^+ (by Na/K substitution) have been studied in the optic lobe of nine isolated frog brains at 10–20 °C. A region 1 mm in diameter was exposed to the solution changes, which were complete within *ca.* 1 s. A staggered pair of θ-glass micro-electrodes (*ca.* 2 μm tip diam.) was used to obtain accurate indications of surface penetration and depth. The gradient of extracellular voltage 0·5 s after the onset of the solution change was restricted to the superficial tissue, falling off with depth with a space constant of 50 μm or less. At later times the extracellular voltage gradient became more gradual, with a depth dependence at 2–32 s corresponding approximately to the profile of extracellular K^+ concentration measured with an ion-selective electrode at these times.

The results suggest that the electrotonic space constant of the glial network in the frog optic lobe, in a direction perpendicular to the surface, is sufficiently short to account for the fast time course of K^+-induced surface negativity without invoking any degree of specialization of glial properties at the tissue surface. The reason why the tissues from frog and from rat brains should have different space constants remains a subject for speculation.

Supported in part by the M.R.C.

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