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THE ROLE OF THE SODIUM-CALCIUM EXCHANGER IN REGULATING
CYTOSOLIC CALCIUM CONCENTRATION IN RAT PANCREATIC B CELLS

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1. The present study was carried out to clarify the role of the $\text{Na}^+/\text{Ca}^{2+}$ exchanger in regulating the cytosolic Ca^{2+} concentration ($[\text{Ca}^{2+}]_c$) in rat pancreatic B cells. To analyze the characteristics of the exchanger, influences of extracellular Na^+ concentration ($[\text{Na}^+]_o$) and various inhibitors on $[\text{Ca}^{2+}]_c$ were examined by a microfluorometric method using Fura-2 in isolated perfused preparations of rat pancreatic islets.

2. Removal of extracellular Na^+ (Na^+_o) caused an abrupt increase in $[\text{Ca}^{2+}]_c$ and partial removal of Na^+_o resulted in respective rises in $[\text{Ca}^{2+}]_c$ in relation to level of reduced $[\text{Na}^+]_o$. A quantitative relation was found between $[\text{Ca}^{2+}]_c$ and $[\text{Na}^+]_o$ over the range 0–146mM. The relation fitted the Hill equation, the coefficient of which was 2.6.

3. Removal of CaCl_2 from the perfusion solution produced a definite inhibition in the $[\text{Ca}^{2+}]_c$ rise induced by the Na^+_o removal, and reintroduction of Ca^{2+} to the Na^+ -deficient environment caused an abrupt increase in $[\text{Ca}^{2+}]_c$.

4. The rise in $[\text{Ca}^{2+}]_c$ induced by the Na^+_o removal was inhibited dose-dependently by Ni^{2+} , which is known to be a competitive inhibitor of Ca^{2+} influx in various types of secretory cells.

5. In contrast, nifedipine (10 μM), which is known to inhibit voltage-dependent L-type Ca^{2+} channels, had little, if any, effect on the $[\text{Ca}^{2+}]_c$ rise induced by the Na^+_o removal.

6. Ouabain (2mM), which is known to inhibit the Na^+/K^+ ATPase, enhanced the $[\text{Ca}^{2+}]_c$ rise induced by the Na^+_o removal.

7. These results are compatible with the view that the $[\text{Ca}^{2+}]_c$ rise induced by the Na^+_o removal is due to an increase in Ca^{2+} influx mediated by the $\text{Na}^+/\text{Ca}^{2+}$ exchanger. This view is supported by the following results; (1) the $[\text{Ca}^{2+}]_c$ rise induced by the Na^+_o removal can be ascribed to a Ca^{2+} influx, (2) the Ca^{2+} influx is not mediated by voltage-dependent L-type Ca^{2+} channels, (3) the $[\text{Ca}^{2+}]_c$ rise depends on the transmembrane Na^+ gradient, and (4) the quantitative relation between $[\text{Na}^+]_o$ and $[\text{Ca}^{2+}]_c$ fits the Hill equation, the coefficient of which was about 3. It is thus concluded that the $\text{Na}^+/\text{Ca}^{2+}$ exchanger plays a cardinal role in the mechanism regulating $[\text{Ca}^{2+}]_c$ in rat pancreatic B cells.