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Bicarbonate Transport in Microperfused Pancreatic Ducts

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The ductal system of the exocrine pancreas secretes a HCO_3^--rich fluid in response to secretin. We have previously reported that interlobular duct segments isolated from guinea-pig pancreas secrete a HCO_3^--rich fluid (> 130 mM) during stimulation with 10 nM secretin (1). To maintain such a high concentration of luminal HCO_3^-, the luminal membrane must be relatively impermeable to HCO_3^- as well as possess mechanisms which specifically transport HCO_3^- into the lumen. To compare the permeability characteristics of the basolateral and luminal membranes of pancreatic duct cells, we examined the changes in intracellular pH that occurred when each membrane was exposed to HCO_3^-.

Intracellular pH (pH_i) was measured in isolated duct segments loaded with BCECF, and the bath and the lumen were perfused separately. When 25 or 125 mM HCO_3^-/5% CO_2 was admitted to the bath, pH_i decreased transiently, due to CO_2 entry by diffusion, and then increased towards the value of the bath pH. This indicates that basolaterally-applied HCO_3^- entered the cell readily until the intracellular concentration of HCO_3^- equaled the bath concentration. The HCO_3^- entry was dependent upon basolateral Na^+, but not Cl^-. When 25 or 125 mM HCO_3^-/5% CO_2 was admitted to the lumen, pH_i decreased rapidly as before but no subsequent increase was observed, indicating that little HCO_3^- entered the cell from the lumen. These data suggest that the luminal membrane acts as a barrier to the re-entry of secreted HCO_3^- while the basolateral membrane allows HCO_3^- to enter the cell easily via Na^+-HCO_3^- cotransport in order to supply HCO_3^- for secretion.

We previously demonstrated activities of Na^+/H^+ exchange, Na^+-HCO_3^- cotransport and Cl^-/HCO_3^- exchange in guinea-pig pancreatic duct cells (2). To localize those transporters, we examined whether the recovery of pH_i from an acid load was dependent on basolateral or luminal Na^+. Acid loading was achieved by adding 20 mM NH_4^+ to the bath for 2 min, followed by Na^+ withdrawal from both the bath and lumen. In the absence of HCO_3^-/CO_2, with the bath and lumen omitted with Na^+, there was no recovery of pH_i. Restoration of luminal Na^+ did not cause any change in pH_i. On restoration of basolateral Na^+, pH_i returned rapidly to the resting value. In the presense of HCO_3^-/CO_2, even with the bath and lumen omitted with Na^+, a small recovery was observed, which was dependent on basolateral HCO_3^- but not on luminal HCO_3^-. Restoration of luminal Na^+ did not alter the rate of changes in pH_i. On restoration of basolateral Na^+, pH_i returned rapidly to the resting value. In the presense of HCO_3^-/CO_2, the removal of Cl^- from the bath solution caused pH_i increase. The removal of Cl^- from the luminal solution similarly caused pH_i increase but the effect was much smaller. This indicates that Na^+/H^+ exchangers, a Na^+-HCO_3^- cotransporter and an unknown HCO_3^--dependent Na^+-independent mechanism for HCO_3^- influx are localized only in the basolateral membrane, while Cl^-/HCO_3^- exchangers are present on both basolateral and luminal membranes.

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