## The Electrical Potential Difference Across The Eel Gill Membrane

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It has been known for some years that chloride is transported outwardly across the eel gill membrane against or in the absence of a concentration gradient. In order to establish that this net transport of chloride is an active process, an attempt was made to measure the electrical potential difference across the eel gill membrane.

An eel heart-gill preparation was set up according to the procedure described by Keys. A T tube connected to a calomel electrode by a KCl agar bridge was inserted into the tubing leading to a cannula inserted into the venous side of the heart. A similar T tube connected by a KCl agar bridge to a second calomel electrode was inserted into the tubing leading to a cannula tied under one operculum. A Leeds-Northrup type K potentiometer was connected in series between the two calomel electrodes. The outflow of fluid perfusing the inside of the gill membrane was collected from a cannula inserted into the dorsal aorta while the outflow from the mouth cavity was collected through a cannula inserted under the other operculum, the mouth having been clamped shut. Both mouth cavity and heart were perfused with eel Ringer's solution.

In 4 successful experiments out of 9 attempted the electrical potential difference between the mouth cavity and the heart ranged between 15 and 30 millivolts with the heart positive to the mouth. Since the gill membrane is by far the largest area between these two regions, it is felt that the observed potential difference occurs chiefly across this structure. Since Schlieper has shown that net outward transport of chloride occurs under the conditions of these experiments (i.e., with eel Ringer's perfusing both sides of the membrane and thus no chloride concentration gradient), the fact that the electrical potential difference is directed against the chloride transport is strong evidence for the occurrence of active chloride transport across the eel gill membrane.

## Salt Transport By Eel Gill Epithelium
## I. Demonstration Of Active Transport Of Both Na and Cl

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It has long been recognized that the isolated, perfused eel gill epithelium secretes NaCl when both sides of the membrane are bathed in Ringer's solution. These experiments were designed to decide whether $Na^+$ or $Cl^-$ or both ions are actively transported during this process. The observations were made on a modification of the Keys eel heart-gill preparation in which the head of the eel was placed in a chamber and the gills exposed to the bathing fluid in the chamber by two incisions which entered the mouth

cavity from the ventral surface of the fish. The electrical potential difference across the gill epithelium was recorded by placing calomel electrodes (with KCl bridges) in the fluid bathing the outside of the gills and in the perfusion fluid entering the heart. Na fluxes in both directions across the gill epithelium were measured by placing $Na^{24}$ in fluid entering the heart and therefore perfusing the inside of the gills and $Na^{22}$ in the bathing fluid out side the gills. In separate experiments, Cl fluxes were measured by placing $Cl^{36}$ either on the inside or outside of the membrane. When Ringer's solution was used on both sides of the gill epithelium, the fluid in the blood vessels was -10 to +15 mV to the fluid outside the gills, while the ratios of outflux (blood to mouth) to influx for both Na and Cl were about 100. Thus, both $Na^+$ and $Cl^-$ are actively transported by the gill epithelium under these conditions. Similar conclusions could be drawn from experiments in which fresh water or sea water bathed the outside of the gills.
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## Salt Transport By Eel Gill Epithelium
## I. Apparent Active Transport Of Both Na And Cl By The Eel Heart-Gill Preparation

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These experiments were designed to decide whether $Na^+$ or $Cl^-$ or both ions are actively transported by the eel gill epithelium. The observations were made on a modification of the Keys eel heart-gill preparation in which the head of the eel was placed in a chamber and the gills exposed to the bathing fluid in the chamber by two incisions which entered the mouth cavity from the ventral surface of the fish. The electrical potential difference across the gill epithelium was recorded by placing calomel electrodes (with KCl bridges) in the fluid bathing the outside of the gills and in the perfusion fluid entering the heart. Na fluxes in both directions across the gill epithelium were measured by placing $Na^{24}$ in fluid entering the heart and therefore perfusing the inside of the gills and $Na^{22}$ in the bathing fluid outside the gills. In separate experiments, Cl fluxes were measured by placing $Cl^{36}$ either on the inside or outside of the membrane. When Ringer's solution was on both sides of the gill epithelium, the fluid in the blood vessels was -10 to +15 mV to the fluid outside the gills, while the ratios of outflux (blood to mouth) to influx for both Na and Cl were about 50.

These data are consistent with the conclusion that both $Na^+$ and $Cl^-$ are actively transported by the gill epithelium under these conditions. However, since substantial net outward fluid movement occurred during these experiments, it is possible that one cause of the high flux ratios is outward filtration across the gill epithelium.

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