

Killifish, Chloride Cells, and Chloride Secretion

Andrea Greenwood¹ and John W. Mills²

Biology Dept.

Fundulus heteroclitus or Killifish are a unique group of fish with adaptations to survive in both fresh and salt waters. Because of this unique ability we call them euryhaline. Killifish absorb salt into their blood when they exist in salt water. Unfortunately the kidney, which is only responsible for getting rid of water, can not excrete the excess salt taken in by each fish. Over time the Killifish have evolved a way in which to excrete this excess salt. They do so by a process called extrarenal salt excretion. This particular process takes place within the gill region and is accomplished by a specialized cell called the “chloride cell.” Killifish also have these chloride secreting chloride cells within the thin epithelial lining called operculum covering their gills. Operculum acts as a barrier separating the blood side of the fish from the actual seawater side. Present in this layer are many different cell types, however, the chloride cell is the only one to reach from the connective tissue of the fish to the seawater side.

Chloride cells have many mitochondria, meaning they produce high amounts of energy. They have what is called an apical crypt located on their seawater side. This crypt is a small surface area where chloride secretion occurs. It is known that chloride secretion begins at the blood side of the fish and ends at the seawater side. Chloride enters chloride cells through a carrier located within the basolateral membrane. It leaves to the seawater side through a chloride channel in the apical membrane. At this time positively charged sodium is pulled through the spaces between cells due to its attraction to the negatively charged chloride. The protein that makes up the channel located in the apical membrane is essentially identical in amino acid sequence to the human protein termed CFTR. This particular protein is the one that is defective in people with Cystic Fibrosis; therefore, studying chloride secretion in Killifish can have direct relevance to a human disease.

The transport characteristics of the opercular epithelial are studied to see how Killifish adapt to seawater from a long-term exposure to freshwater. If the amount of chloride secreted is known we can determine how and why and what causes the secretion. If there is a decrease in chloride secretion we can determine whether or not there is an absence in chloride cells or possibly a change in their morphology. It was found that in freshwater chloride transport is low, however, as the time in seawater increases, the ability to secrete more chloride increases.

¹ Class of 2000, Biology Department

² Professor, Clarkson University