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IONS AND WATER TRANSPORT ACROSS THE EPITHELIAL CELL LAYER

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Epithelial cell form a one or more layers covering an external surface of the tissue or lining a cavity of glands. The layer is coherent. Cells are connected by tight junctions. The trans epithelial cell layer *in vitro* has the electrical resistance 200–1000 [ohm/cm^2]. The epithelia are polarized. Upper (apical) cell surface has different protein composition than lower (basolateral) surface. The difference in the protein composition can cause the directional flow across the cell layer. The major function of epithelia is to transport water, ions and other molecules. Passive or active transport of ions causes osmotic flow of water.

The defect in single gene coding chloride channel (CFTR) in epithelia causes the most common fatal disease – cystic fibrosis. The CFTR protein in localized in the apical cell surface and is activated by cAMP. The efflux of chloride ions and electrogenic sodium ion flow via paracellular way causes the water osmotic across the epithelia diluting the fluid secreted in lungs, pancrease and guts.

In the studies of transport properties in epithelia Ussing chamber is being used. In Ussing chamber total current flowing through the cell layer could be determined in voltage clamp or current clamp regimes. Sometimes radioactive isotopes are used. There are only few studies in which water transport through epithelial cell layer was determined. All the studies have the major flaw – lack of parallel determination of major ions and water flow. Few other techniques are also used – patch clamp together with channel activators and blockers to determine ion channels of the cell membranes, siRNA or knock out animals to determine the role of single protein on the transport properties, fluorescent microscopy to determine the localization of the given protein in the membrane.

Thirty years ago it was generally believed that there are only few ion channels on the epithelial cell surface. We know now that this is not the case. On the apical surface there are at least three chloride channels: CFTR, VSOR, CLCA; potassium channel: ROMK and sodium channel: ENaC. There are also ion exchangers: Na/H, K/Na, Cl/HCO_3, KHATPase pump and aquaporin channel AQP3. On The basolateral surface there are chloride channels: ORCC, ClC_2, Bestrophin and Glycine receptor; potassium channel K(Ca); voltage gated sodium channel: Nav; exchangers: NaK_2Cl, Na_2HCO_3,Cl/HCO_3, and NaKATPase pump. There are ATP receptors P2Y both on apical and basolateral surfaces. Not all the channels are present in all types of epithelial tissues.

There are data suggesting that activation of epithelial cell via P2Y receptors activate two different cellular responses. ATP applied apically increases the intracellular calcium concentration while applied basolaterally increases the cAMP concentration leading probably to the opposite direction of water transport.

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