SEMINAR

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Mathematical modeling of complex physiological systems

We developed a mathematical model of the thick ascending limb (TAL) segment of the nephron (a nephron is a tubule that is the functional unit of the kidney). The model consists of a set of PDEs (based on mass conservation) that represent luminal and cytosolic concentrations, cell volume, and tubular fluid flow as function of time and location along the TAL. The model includes a detailed description of the major transcellular and paracellular transport processes that govern water and solute flux between the different compartments represented by the model. Furthermore, cell volume and pH regulation mechanisms are also included in the model. The model equations were solved numerically and from the results we considered important physiological issues like: efficiency of tubular fluid dilution in the TAL and the filtering properties of the TAL at the cellular and whole-segment level. The inclusion of the TAL model into mathematical models of the outer medulla region of the kidney is also discussed. Finally, we discuss how the modeling framework used in this model of the TAL can be used in other physiological systems, not necessarily related to the kidney.

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