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An approach to expand description of the pump and co-transporter steady-state current

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Abstract

The membrane transporters (pumps and co-transporters) are the main players in maintaining the cell homeostasis. Models of various types, each with their own drawbacks, describe transporter behavior. The aim of this study is to find the link between the biophysically based and empirical models to face and solve their specific problems. Instead of decreasing the number of states and using few complex rate constants as is usually done, we use the number of states as great as possible. Then, each transition in the cycle can represent an elementary process and we can apply the mass action law, according to which if rate constants depend on concentrations the dependence is linear. Thus, the expression for the steady state transporter current can be transformed from a function of rate constants into a function of concentrations. When transporter states form a single cycle, it can be characterized by two modes of action – forward and backward ones. Specific mode is realized depending on the available free energy. Each mode of action is characterized by a set of transporter affinities together with a parameter that describes the maximal turning rate. Except standard affinities corresponding to the substances that are binding to the transporter, affinities for the substances that are released are also defined. Such scheme provides great possibilities to construct approximations as each individual affinity could be estimated from experiments as precisely as possible. The approximations may be used for not only description and study of