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Model of concentration changes across the synaptic cleft during a single quantum release

Skorinkin A., Shaihutdinova A., Vyskočil F.
Kazan Federal University, 420008, Kremlevskaya 18, Kazan, Russia

Abstract

A model of concentration changes across the synaptic cleft during a single quantum release is presented that can be used for description and characterization of the kinetic in postsynaptic current development under the influence of different antagonists, modulators, desensitization promoters or complex channel blockers. The model enables the calculation of the relative number of open channels as a function of time for two standard cases - when acetylcholinesterase (AChE) is either active or inhibited. One outcome of the present model is that the variable part of AChE activity is zero at the moment of acetylcholine (Ach) release and then increases. This is in contrast to common view that the activity of AChE at the initial moment of release of quanta is maximal and decreases over the time course of quantum action. However, the model explains why non-quantal ACh leakage from the nerve terminal creating a concentration of approximately 10-8 mol·1-1 in the cleft can escape hydrolysis by intrasynaptically located cholinesterase and reach the subsynaptic membrane. The model can also be used for theoretical considerations of time and amplitude changes during repetitive nerve-evoke quanta release.

Keywords

Acetylcholine, Acetylcholinesterase, Model synapse, Release of quanta