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# Modeling signal transduction in synaptic plasticity: comparison of models and methods

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Long-term activity-dependent strengthening (LTP) and weakening (LTD) of synapses are two forms of synaptic plasticity. Both LTP and LTD participate in storing information and inducing processes that ultimately lead to learning and memory (e.g., [1]). Several mechanisms have been shown to be the reason for changes in synaptic strength, for example changes in neurotransmitter release, conductivity of receptors, numbers of receptors, numbers of active synapses, and structure of synapses [2]. At present, there are more than hundred molecules found important in LTP and LTD.

Several computational models, simple and more complex ones, have been developed to describe the mechanisms behind synaptic plasticity at the biochemical level. Simplest models have only one reversible reaction and most complicated ones have several hundred reactions.

In this study, we evaluate different computational models for describing LTP and LTD phenomena. Selected models, including both simplified (e.g., [3,4]) and biophysically more detailed (e.g., [5,6]) ones, are implemented, and their behavior is simulated with well-established deterministic and stochastic approaches [7]. Especially, we concentrate on the input-output relationship in simulations of the models. When using the same input, many of the models are found to give different responses. One of the reasons is that some of the models studied can mimic both the induction and maintenance of synaptic plasticity, whereas others are found to explain only the induction. Furthermore, the role of some specific molecules important in LTP and LTD is studied. Even thought the simplest models do not take into account all the details in biological knowledge, they can be used to predict different events, which is very important when modeling synaptic plasticity. The ultimate goal of this work is to provide realistic, yet simple enough models for describing LTP and LTD phenomena and addressing the general principles of information storage in neurons.

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