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Modeling firing patterns of medium spiny neurons

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The alternation in firing patterns of medium spiny neurons of the Nucleus Accumbens, a key structure in the brain's reward pathway, due to chronic and acute cocaine use was investigated through change of ion channel and receptor properties. Cocaine causes cellular changes both in the proteomic and genomic level in medium spiny neurons by increasing the concentration of the neurotransmitter Dopamine in the synaptic region; therefore generating a biologically realistic model of the nucleus accumbens is necessary. Medium spiny neurons exhibit bistability, meaning that they pass through up (polarized) and down (hyperpolarized) phases of membrane potential periodically. Only in the up state will a cell fire a train of action potentials. First step in the long term project of studying cocaine addiction is modeling this complex firing pattern and quantifying what can cause it to change. This task required figuring out all the key ion channels and receptors that mediate bistability, the equations that govern their behavior, and finally putting everything together in a computer program called GENESIS.