

1033-35-248

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Variability of the Single Photon Response in Rod Phototransduction.

The rod outer segment (ROS) transforms light signals into electrical pulses thereby initiating vision. The biochemical cascade generated upon absorption of a photon by a receptor molecule (Rhodopsin) is highly variable. However electrophysiological measurements reveal a surprising reproducibility (stability) of the phenomenon. Essentially the coefficient of variation (CV, standard deviation of the response over its mean) is relatively low. We have generated a mathematical model of the visual transduction cascade, based on homogenization and concentrated capacity, that permits a mathematical and numerical analysis of the various compartments of the process as single modules. We will review the basics of phototransduction, describe the model, introduce the notion CV for the phototransduction activating cascade and compute it theoretically and numerically. We will describe a series of stochastic numerical experiments and relate them to the underlying biochemistry. Analysis of these results permits one to give an explanation of the expected high variability versus the observed low variability, in terms of modular contribution of the random elements of the process. (Received September 12, 2007)