A Fixed-Point from MAPK Cascade and a Measure for Cellular Signaling

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In cellular signal transduction networks, one of the well-known functions of MAPK (Mitogen-Activated Protein Kinase) cascade is to act as an amplifier for intracellular signaling processes. But, an unexpected phenomenon – a fixed-point that occurs at a four-layered MAPK cascade where a feedback is embedded – is observed by simulation [1], which shows that in theory the second messengers' signals can be kept in a constant value during their relay processes within cells. Based on Michaelis-Menten kinetics, a scheme for encoding intracellular signals – phosphoproteins and GTPases – is proposed [2, 3]. For an individual phosphorylation pathway regulated by a kinase, the measure of mutual information is estimated by encoding the concentration of phosphoproteins, and the maximum value of mutual information (i.e., channel capacity) – 1 bit/per pathway – is obtained [4]. Consequently, Michaelis-Menten kinetics can be the dynamics basis of information-theoretical study on the cell communications although the simulation of signal transduction network reported here is still empirical. However, Katori-Masuda-Aihara's method [5] has been proven to be successful for neural codes and the network dynamics with gap junctions. The next step of the computational study on cellular signal transduction networks will be to formulate a model to quantify the dynamics of cellular signal transduction networks based on mutual information measures [5].

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