

Molecular mechanism of the Mg²⁺ channel MgtE

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MgtE is a Mg²⁺ selective channel widely distributed in all domain of life and is involved in the maintenance of intracellular Mg²⁺ homeostasis. The previously-reported X-ray structures and electrophysiological analyses of MgtE suggested the intracellular Mg²⁺-dependent gating mechanism of MgtE. The high resolution Mg²⁺-bound crystal structure of the transmembrane domain clearly visualized the fully-hydrated Mg²⁺ ion within its selectivity filter. Based on the results, we proposed a cation selectivity mechanism for MgtE in which the geometry of the hydration shell of the fully-hydrated Mg²⁺ ion is recognized by the side chain carboxylate groups in the selectivity filter, in contrast to the K⁺-selective filter of KcsA. We also report here the crystal structure of MgtE complexed with ATP, which is strictly recognized in the cytosolic CBS domain. Further functional analyses revealed that ATP is a regulatory factor of MgtE to switch the mode of the channel gating. The ATP binding to MgtE enhances the affinity of MgtE for Mg²⁺ within a physiological range, enabling MgtE to act as a Mg²⁺ sensor in vivo, whereas the ATP dissociation from MgtE upregulates the Mg²⁺ influx even at the high intracellular Mg²⁺ concentration, possibly facilitating the ATP synthesis.

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