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Inhibitions of H^+-ATPases and Ion Channels by Lanthanum

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Many physiological processes of plant cells, such as nutrient uptake, salt tolerance, and cell enlargement, are mediated by ion transports across the plasma membrane. H^+-ATPases on both plasma and vacuolar membranes play major roles on active transports and ion channels mediate passive transports of various ions. It has been known that these proteins involved in cellular osmotic regulation and salt tolerance in the salt-accumulated soils. Nevertheless, the physiological roles of ion pumps and ion channels are not known in detail. In order to find a new ligand which is able to modulate cellular physiology, the effects of La^{3+} were investigated on the activities of ion pumps and ion channels. Tight-sealed microsomes were prepared from the roots of tomato plant. Microsomal H^+-ATPases of plasma and vacuolar membranes were analyzed by using specific inhibitors, vanadate and NO_3^-, respectively. Activities of these two enzymes were 60-70% of total microsomal ATPase activity. La^{3+} inhibited these H^+-ATPases in a dose-dependent manner. Interestingly, the inhibitory effect of La^{3+} was quantitatively suppressed by the additions of vanadate and NO_3^- and the suppression was overcomed by the addition of ATP. These results imply that La^{3+} only inhibits these two H^+-ATPases by decreasing the affinity of ATP binding but it dose not inhibit other microsomal ATPases. La^{3+} also blocked the activities of ion channels. Two types of ion channels were isolated with conductances of 430 pS and 460 pS. These channels were completely inhibited by 1 mM La^{3+}. Therefore, La^{3+} is a very good modulator which is able to inhibits both H^+-ATPases and ion channels simultaneously. La^{3+} could be a potent tool to study the dynamic coupling between ion pumps and ion channels in a single cell.