ID of Osmotic Stress Induced Changes in Ionic Fluxes of Growing Root Hairs

Lew, Roger

Marine Biological Laboratory, Woods Hole, MA, United States

Abstract

Recent research on the pressure regulation of electrical properties of Arabidopsis thaliana cells revealed that growing root hairs were unaffected by direct modulation of pressure. However, indirect modulation of the intracellular hydrostatic pressure using changes in external osmoticum (mannitol and sorbitol) caused the membrane potential and conductance of the growing root hairs to change (1). The changes were likely due to modification of ionic fluxes across the plasma membrane and precede gene expression of a MAPKK kinase homolog (2) induced by osmotic stress within 5 minutes (3). The self-referencing ion-selective probes at the BioCurrents Research Center offered an effective, non-invasive way to determine what ions contributed to the electrical changes of root hairs during osmotic stress. The experimental protocol was as comprehensive as possible an examination of ionic fluxes and other parameters. Measurements included not only the ionic fluxes of protons, calcium, potassium and chloride in either hyper-osmotic or hypo-osmotic solutions but also the growth rates of the root hairs that were being measured, and the effect of perfusion with either hypo-osmotic or hyper-osmotic solutions. At present, the data obtained at the BioCurrents Research Center are still being analyzed. Preliminary highlights (subject to revision): Calcium appears to behave as an osmotically 'active' agent: the normally inward flux increased after hyper-osmotic treatment and decreased after hypo-osmotic treatment. Normally outward currents of protons decreased after both hyper-osmotic and hypo-osmotic treatments. Of these two ions, only the proton flux appears to be correlated with growth rate (negatively). These and other results yet to be analyzed offer insight into the immediate osmo-responses of the growing root hairs. Needless to say, the experiments would not have been possible without the availability of the BioCurrents facility. The success of my visit has encouraged my collaborators and myself to consider additional visits to characterize the ionic currents of fungi such as Saprolegnia ferax (4-6), a known pathogen of fish, and Neurospora (7) as a model for tip growth in a 'terrestrial' organism that may be pertinent to understanding invasive growth of fungal pathogens in humans. A repeat visit is scheduled for November, 1997. References 1. Lew, R.R. 1996. Pressure regulation of the electrical properties of growing Arabidopsis thaliana L. root hairs. Plant Physiol. 112: 1089-1100. 2. Covic, L. and Lew, R.R. 1996. Arabidopsis thaliana cDNA isolated by functional complementation shows homology to serine/threonine kinases. Biochim.

Biophys. ActaH0441305:125-129. 3. Covic, L., silva, N. and Lew, R.R. 1996. Functional characterization of ARAKIN: a possible mediator in an osmotic signal transduction pathway in plants. (Submitted). 4. Garrill, A., Lew, R.R. and Heath, I.B. 1992. Stretch-activated Ca2+ and Ca2+-activated K+ channels in the hyphal tip plasma membrane of the oomycete Saprolegnia ferax. J. Cell Sci. 101:721-730. 5. Garrill, A., Jackson, S.L., Lew, R.R. and Heath, I.B. 1993. ion channel activity and tip growth: tip-localized, stretch-activated channels generate a Ca2+ gradient that is required for tip growth in the oomycete Saprogegnia ferax. J. Eur. Cell Biol. 60: 358-365. 6. Levina, N.N., Lew, R.R. and Heath, I.B. 1994. Cytoskeletal regulation of ion channel distribution in the tip-growing organism Saprogegnia ferax. J. Cell Sci. 107: 127-134. 7. Levina, N.N., Lew, R.R., Hyde, G.J. and Heath, I.B. 1995. the roles of calcium ions and plasma membrane ion channels in hyphal tip growth of Neurospora crassa. J. Cell Sci. 108:3405-3417.

Funding Agency

Agency	National Institute of Health (NIH)
Institute	National Center for Research Resources (NCRR)
Type	Biotechnology Resource Grants (P41)
Project #	5P41RR001395-16
Application #	6281123
Study Section	
Project Start	1997-12-01
Project End	1998-11-30
Budget Start	1997-10-01
Budget End	1998-09-30
Support Year	16
Fiscal Year	1998
Total Cost	
Indirect Cost	

Institution

Name	Marine Biological Laboratory
Department	
Type	
DUNS #	001933779
City	Woods Hole
State	MA
Country	United States
Zip Code	02543