CC/NUMBER 8
FEBRUARY 23, 1981

This Week's Citation Classic

Lyons J M & Raison J K. Oxidative activity of mitochondria isolated from plant tissues sensitive and resistant to chilling injury. *Plant Physiol.* **45**:386-9, 1970. [Plant Physiol. Unit, CSIRO, Div. Food Preservation, Ryde, and Sch. Biol. Sci., Univ. Sydney, Australia]

Respiration rates of mitochondria derived from plants sensitive and resistant to chilling injury were examined as a function of temperature *in vitro.* **Marked differences between the two groups led to articulation of a hypothesis that a** phase change occurs **in cellular membranes as a result of a physical effect of low temperature** in **the** 10 **to 12° C range which** does not occur in chilling resistant species. [The *SCI*® indicates **that this paper has been cited** *over* 115 times since 1970.]

James M. Lyons
Department of Vegetable Crops
College of Agricultural and
Environmental Sciences
University of California
Davis, CA 95616

January 26, 1981

"These experiments were initiated in an attempt to explain the mechanism by which brief exposure of warm season crops to cool temperatures below 10-12°C (but above freezing) causes injury, while cool season crops can function happily down to 0°C. Horticultural losses from this low temperature trauma have stimulated scientific inquiry for many decades and, as a result, many explanations have been offered for the primary lesions caused by low temperature.

"I was interested in the question and my early experiments began to build supporting evidence that the lipids might be involved in this response, and particularly lipids in the cellular membrane.

"An opportunity for sabbatical leave in Australia, sponsored by the Australian CSIRO, division of food preservation, brought me together with John Raison, scientific officer in the plant physiology unit at Sydney University. John had a keen interest and much experience in mitochondrial energetics. We devised methods to extract mitochondria from both chill-resistant and chill-sensitive plants and measured their oxidative activity over a temperature range from 0 to 30°C. The results were definitive: those from resistant species exhibited a linear reduction in rate from 30 down to 0°C; those from sensitive species exhibited a marked depression in rate below 10-12°C. These results were consistent with the notion that solidification of lipids, at least in membranes, could be the primary event of the low temperature response. Our paper presenting these findings was selected for the AIBS-Campbell Award in 1971 and subsequent publications have further substantiated these findings.

"Why is this publication so frequently cited? Perhaps because it provided a plausible, unifying concept on how exposure to low temperature, even for a relatively short period in some cases, could cause such a range of physiological dysfunctions leading to cell injury and death. Subsequently, many different experiments have provided results consistent with this hypothesis and many researchers found comfort in organizing their experimental results around such a relatively simple and straightforward conceptual framework. Hence, their many citations.

"Perhaps the citations are numerous because many others disagree. There are those who consider the work trivial and offering no real explanation of how low temperature elicits a plethora of responses in chilling-sensitive plants. There are those who suggest that the real receptor of the temperature stimulus must be a protein, or the result *of* interactions between lipids and proteins, and still others who suggest there can be no unifying concept. In fact, this controversy provided the basis for a recent symposium on the topic.[1]

"The evidence to date is not final. The hypothesis that membrane lipids can be the controlling transducer in the low temperature response is destined to be decided by further experimentation. Perhaps this tells us, then, that the 'how' and 'why' a publication becomes a *Citation Classic* is dependent upon presenting a simple and plausible hypothesis, one that *can* be highly controversial, and yet one that will escape definitive experimental resolution for many, many years. Scientific protocol will guarantee citations."

1. **Lyons J M, Graham D & Raison J K.** *Low temperature stress in crop plants: the role of the membrane.* New York: Academic Press, 1979. 565 p.