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Calcium influx during fertilization in mammalian oocytes

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Abstract

In mammals, the fertilizing sperm activates the oocyte's developmental program by triggering a long series of calcium transients in the ooplasm. The transients are the result of repetitive release and re-uptake of calcium by the intracellular stores. The repetitive nature of the signal is critical for normal fertilization: the amplitude, frequency and duration of the transients encode information crucial for embryo development. Although it is fairly clear how the fertilizing sperm triggers the release of calcium from the intracellular stores, less is known about another process that occurs concomitantly, a calcium influx across the plasma membrane. In many non-excitable cells the release of calcium from intracellular stores generates the entry of extracellular calcium through a mechanism known as store-operated calcium entry. The key molecular components of the cascade have recently been identified as STIM1 being the calcium sensor and signal transducer, and Orai1 as the protein that makes up the entry channels. Research in our laboratory using pig oocytes indicates that these proteins also play a critical role during fertilization. In the absence of either STIM1 or Orai1 the train of calcium oscillations cannot be sustained and embryo development is compromised. Store-operated calcium entry was also demonstrated in mouse oocytes and data imply that the calcium influx per se may be necessary for complete activation of the oocyte. A better understanding of the mechanism offers benefits not only in the field of assisted reproductive technologies but indirectly, in the production of genetically modified animals via somatic cell nuclear transfer.

Biography

Zoltan Machaty received his Ph.D. from Szent Istvan University, Hungary in 1993 and completed his postdoctoral studies at the University of Missouri-Columbia in 1997. He is currently an associate professor at the Department of Animal Sciences at Purdue University. He has published more than 50 papers in peer-reviewed journals and serves as an editorial board member for the journal Cloning and Transgenesis.