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THE POLLEN TUBE – AN IDEAL MODEL SYSTEM TO STUDY NON STATOCYTE PLANT CELL RESPONSE TO GRAVITY

Abstract

Future space missions and implementation of permanent bases on the Moon and Mars will greatly depend on the availability of ambient air and sustainable food supply. Therefore, understanding the effects of micro-gravity on plant reproduction is vital for future extra-terrestrial human existence. Numerous studies have demonstrated the effect of gravity acceleration or its absence on plant development in general and on statocyte cells in particular. However, the molecular basis of cellular behaviour in response to gravity associated signals is poorly understood. Unlike statocyte-type cells, most plant cells are not specially equipped to perceive gravity signals, yet they are known to react. Therefore, understanding the regulation of the signalling pathways involved in the response to changes in gravity and the relationship to subsequently induced metabolic changes is crucial. While intracellular signalling cascades are triggered immediately upon the perception of an external mechanical signal, metabolic cellular responses can take up to several hours or days to be measurable thus providing a critical lower time limit for the duration of experimentation. The use of rapidly growing cells with high metabolism can lower this parameter to make experiments fit into the time frame of parabolic flight or sounding rocket experiments. The fastest growing cell in the plant kingdom is the pollen tube, a tip growing cellular protuberance formed by the pollen grain that is responsible for fertilization, and consequently for seed set and fruit formation in higher plants. Even in in vitro conditions the pollen tube grows at up to 10 or 20 micrometers per minute and it responds instantly and visibly to environmental changes. This rapid response makes it an optimal model system to study the effects of gravity changes on plant cell metabolism. In addition, the pollen tube's growth mechanism and cell biology are extremely well investigated and thus benchmark values for numerous cellular parameters are available such as spatial and temporal regulation of cell wall synthesis, cytoskeletal control of intracellular trafficking, ion control of growth dynamics etc. The latter point is of particular interest as calcium was shown to be implicated in signalling pathways leading to a graviresponse in statocyte cells, but almost nothing is known on its role associated with the gravity response in non-statocyte plant cells. Our objective is therefore to establish a standardized experimental system to characterize signalling pathways and metabolic behaviour in non-statocyte plant cells upon gravity signals in short term experimentation experiments.