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Plant Cell Totipotency: An overview

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Abstract

Plants generally have the highest regenerative ability because they show a high degree of developmental plasticity. Although the basic principles of plant regeneration date back many years, understanding the cellular, molecular, and physiological mechanisms based on these principles is currently in progress. In addition to the significant effects of some factors such as medium components, phytohormones, explant type, and light on the regeneration ability of an explant, recent reports evidence the involvement of molecular signals in organogenesis and embryogenesis responses to explant wounding, induced plant cell death, and phytohormones interaction. However, some cellular behaviors such as the occurrence of somaclonal variations and abnormalities during the in vitro plant regeneration process may be associated with adverse effects on the efficacy of plant regeneration.

Introduction :

Cellular totipotency was first proposed by German botanist Haberlandt in 1902. Totipotency is the ability of a plant cell to give rise to an entire new plant. Plant cells are totipotent cells. This ability of plants cells allows them to be utilised for plant propagation and improvement.Totipotent plant cells are used in micropropagation of plants. Micropropagation is a technique to grow, store, and maintain a large number of plants in small spaces. It is useful in germplasm collection and the protection of endangered species. It produces an improved variety of crop plants - disease resistant plants. In a mature plant, meristematic tissues actively divide and are essentially totipotent cells. But permanent tissues are those who have lost the ability to divide and have differentiated into a specific cell type. In order to induce totipotency the permanent tissues must lose their function and start dividing.

Cellular totipotency is the ability of a living somatic nucleated cell to form the completeorganism. Theoretically all somatic cells should be totipotent since they carry the

full gene component of the individual. During their maturation the cells undergo differentiation and are unable to return to their undifferentiated status but they, do so under special circumstances and the phenomenon is called dedifferentiation. The dedifferentiated cells can undergo division and ultimately form the whole individual or a part of it. Totipotency can be easily demonstrated in plant cells. In higher animals it has not yet been experimentally proved because the cells do not undergo independent tissue differentiation. Nucleus taken from any living somatic cell can be shown to have complete genetic information and hence totipotent. This can be done by implanting it in an egg where the original nucleus has been removed. The egg develops normally into a new individual similar to the parent which donated the nucleus. The technique was successfully demonstrated by Wilmut and Campbell when they cloned the first mammal, sheep Dolly.

The method of totipotency is used in :

(a) Multiplication of rare plants which reproduce through seeds with great difficulty.

(b) Induction and selection of mutants.

(c) Rapid multiplication of desired plants.

(d) Multiplication of sterile hybrids.

(e) Production of virus-free plants.

(f) To develop embryos which fail to reach maturity.

(g) Shorten the period for development of new varieties.

(h) Development of resistance to chemicals like weedicides.

(i) Multiplication of products of protoplast fusion.

Conclusion :

Plant cells have an extraordinary capacity for totipotency, that is the ability to producea new organism through somatic embryogenesis. A critical step in this process is the transition from somatic cells to totipotent cells, which is achieved by the reprogramming of somatic cells. Accumulating evidence indicates that a regulatory network composed of transcription factors and epigenetic factors plays an essential role in the generation of totipotent cells and somatic embryos. It appears that each of these factors can activate the entire network regulating the reprogramming process and that auxin functions as an integral part of this network.

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