PLANT TISSUE CULTURE-HISTORY AND CONCEPTS

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INTRODUCTION

Experimental systems based on plant cell and tissue culture are characterized by the use of isolated parts of plants, called explants, obtained from an intact plant body and kept on, or in a suitable nutrient medium.

This nutrient medium functions as replacement for the cells, tissue, or conductive elements originally neighboring the explant. Such experimental systems are usually maintained under aseptic conditions.

Otherwise, due to the fast growth of contaminating microorganisms, the cultured cell material would quickly be overgrown, making a rational evaluation of experimental results impossible.

HISTORY OF TISSUE CULTURE

- 1838- Cell theory, indicating towards totipotentiality of cells by **Schleiden** and **Schwann**.
- 1902- First but unsuccessful attempt of tissue culture using monocots by **Haberlandt.** He also explained the concept of cell totipotency**.**
- 1904- First attempt in embryo culture of selected Crucifers by **Hannig.**
- 1922- A symbiotic germination of orchid seeds by **Knudson**.
- 1922- *In vitro* culture of root tips by **Robbins.**
- 1924- Callus formation on carrot root explants by use of lactic acid by **Meyer**.
- 1934- *In vitro* culture of cambial tissues of different trees and shrubs failed by **Guatheret.**
- 1934- Identification of the first plant hormone, IAA leading to cellenlargement by **Kogl.**

HISTORY OF TISSUE CULTURE

- 1941- Coconut Milk used for growth and development of very young Datura embryos by **Overbeek.**
- 1942- Observation of secondary metabolites in plant callus cultures by**Gautheret**.
- 1943- Tumor-inducing principle of crown gall tumors identified by **Braun**.
- 1944- First *In vitro* culture of tobacco used to study adventitious shoot formation by **Skoog.**
- 1946- First whole plants of *Lupines* and *Tropaeolum* from shoot tips by **Ball.**
- 1948- Formation of adventitious shoots and roots in tobacco by **Skoog**.
- 1957- Discovery that root or shoot formation in culture depends on auxin:cytokinins ratio by **Skoog** and **Miller.**
- 1958- *In vitro* culture of excised ovules of *Papaver somniferum* by **Maheshwari**.
- 1958- Regeneration of somatic embryos from nucleus of Citrus ovules by **Maheshwari and Rangaswamy**.

HISTORY OF TISSUE CULTURE

- 1962- Development of MS medium by **Murashige and Skoog.**
- 1964- First haploid plants from Datura androgenesis by **Guha and Maheshwari.**
- 1973- Cytokinins found to be capable of breaking dormancy in *Gerberas* by **Pierik**
- 1978- Somatic hybridization of tomato and potato resulting pomato by **Melchers.**
- 1978- Industrial scale fermentation of plant cells for production of shikonin.(Selection of cell lines with higher yield of secondary products) by **Tabata.**
- 1981- Introduction of the term somaclonal variation by **Larkin**.
- 1981- Isolation of auxotroph by cell colony screening in haploid protoplasts of *Nicotiana plumbaginifolia* treated with mutagens by **Sidorov.**
- 1985- Infection and transformation of leaf discs with *Agrobacterium tumefaciens* and regeneration of transformed plants by **Horsch.**

COMMON TERMS USED IN TISSUE CULTURE

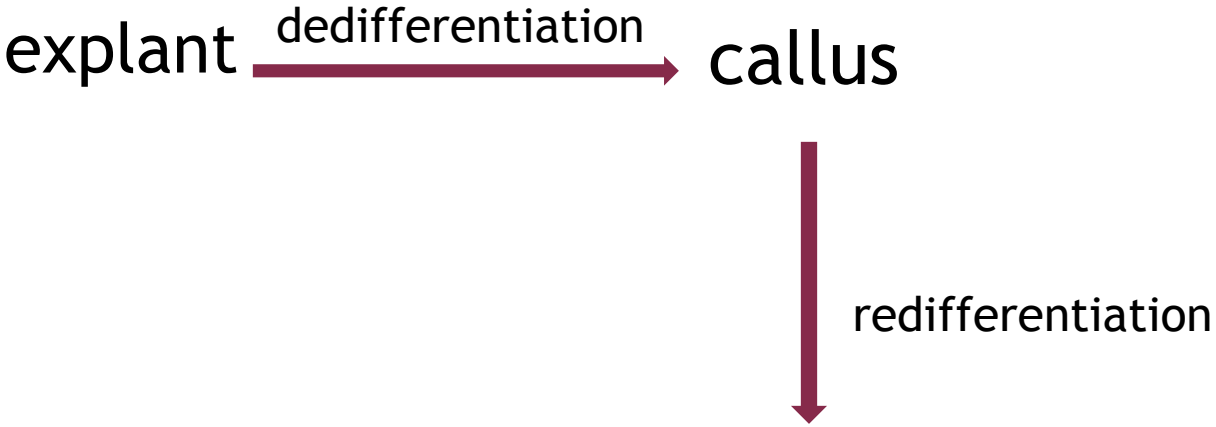
- Aseptic culture is a culture which is free from any micro organism
- Cell culture is the culture of single cells which are isolated mechanically or enzymatically from plant tissues and maintained under *in vitro* condition
- Cell suspension culture is a liquid culture medium containing a few cells in clumps maintained under *in vitro* condition
- Tissue culture is the growth or maintenance of tissues *in vitro* in such a way that they maintain their differentiated state
- Organ culture is the growth or maintenance of organs (eg. leaves) *in vitro* in such a way that they maintain their functions
- Caulogenesis is the technique of formation of shoot under *in vitro* conditions
- Rhizogenesis is the technique of formation of root under *in vitro* conditions
- Medium is the nutritive solution (liquid or semi solid) to culture cells
- Clones are plants produced asexually from a single parent source. All the clones are genetically similar
- Explant is a piece of tissue taken from root, stem, leaf, flower or even seed of mother plant for culture
- Callus is an unorganized proliferating mass of undifferentiated cells formed as a wound response
- Callogenesis is the formation of callus under *in vitro* conditions
- Subculture is the process of maintenance of plant cultures by subdividing them and then transferring them to fresh medium

TOTIPOTENCY

- It is the characteristic of the plant cell to produce all the cell types that are present in the particular adult plant thus making it capable to give rise to the entire plant
- In plants even highly mature and differentiated cells are capable of returning back to a **meristematic state** as long as they have **intact membrane system** and a **viable nucleus**
- Reverting back to meristematic state requires replacement of non functional cellular components damaged by lysosomal activity during the process of cytoquiescence

DEDIFFERENTIATION AND REDIFFERENTIATION

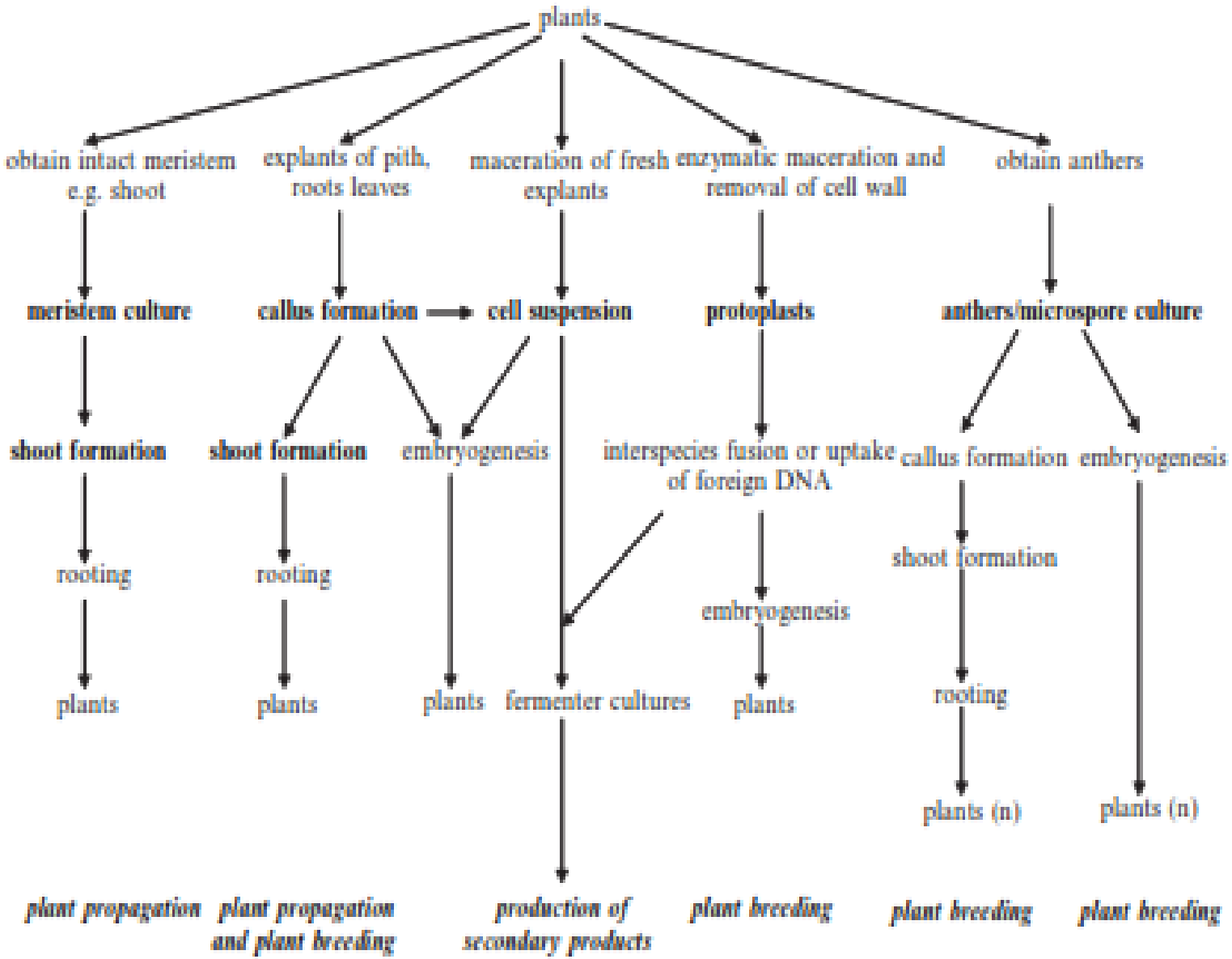
The concept of totipotency in tissue culture is based on two different processes:



Dedifferentiation is the process in plant tissue culture by which the mature cells which are committed to a specific structure and function return to meristematic condition and give rise to undifferentiated mass of cells (callus)

Redifferentiation is the process by which the undifferentiated cells assume specific shape, size and function of a specific cell type. This process when accompanied by caulogenesis and rhizogenesis or directly by formation of somatic embryos can give rise to plantlets.

Scope of plant tissue culture



SCOPE OF PLANT TISSUE CULTURE

1. Micropropagation using meristem and shoot culture technique allows formation of large number of uniform individuals(clones) in a short time from limited starting material
2. Crossing of distantly related species by protoplast isolation and fusion increases the possibility of forming interspecific hybrids
3. Production of dihaploids from haploid cultures shortens the time needed to achieve uniform homozygous lines
4. Cell selection can increase the potential number of viable individuals in a screening program
5. Bioreactors can be used to grow plant cells on a large scale for commercial production of particular metabolite
6. Genetic transformation of single cells can be done from which entire transgenic plants can be obtained
7. Plant tissues can be frozen (Cryo-preservation) and then regenerated through tissue culture. It preserves the pollen and cell collections from which plants may be propagated according to requirement.