



A HISTORY OF PLANT BIOTECHNOLOGY

Plant Biotechnology

- Plant biotechnology is founded on the principles of cellular totipotency and genetic transformation.
- Traced back to the Cell Theory of M.J.Schleiden and T.Schwann.
- Discovery of the genetic transformation in bacteria by Frederick Griffith.

Introduction

- Eighteenth Jan 1983, three independent groups described *Agrobacterium tumefaciens*-mediated genetic transformation, leading to the production of normal, fertile transgenic plants.
- Introduced a bacterial antibiotic resistance gene into tobacco.

Objective

- Scientists believe that the new technology would allow introduction of agronomically important genes into crop species that are susceptible to agro-bacterial infections.



THE CELL THEORY

Schleiden & Schwann

Schleiden (1838):

- Every plant and animal is “an aggregate of fully individualized, independent, separate beings”, that is, cell.

Schwann (1839):

- “Some of these elementary parts (cells) which do not differ from others, are capable of being separated from the organism and continuing to grow independently.”

Cell Theory:

- All living things are composed of cells.
- Cells are the basic unit of structure and function in living things.
- Cells arise from pre-existing cells.

Virchow (1858):

- “Where a cell arises, there must have been a cell before, even as an animal can come from nothing but an animal, a plant from nothing but a plant...nor can any developed tissue be traced back to anything but a cell”

Revival of Cell Theory:

- Interest in the Cell Theory was revived in 1858 by the famous aphorism of Ludwig Karl Virchow:
 “Omnis cellula a cellula” (all cells arise from cells).
- He determined that diseased cells always arose from healthy cells, and rejected the prevailing view of spontaneous generation.

Revival of Cell Theory:

- Herman Vöchting (1878), attempted to demonstrate totipotency experimentally by dissecting and growing smaller and smaller fragments of plant tissues.



TOTIPOTENCY

Gottlieb Haberlandt

Totipotency

- Totipotency is the ability of a single cell to divide and produce all the differentiated cells in an organism, including extra embryonic tissues.

Totipotency of Plant Cell

- Gottlieb Haberlandt was the first to try to obtain experimental evidence of totipotency by culturing plant cells in nutrient solutions in hope of regenerating whole plants.

Gottlieb Haberlandt Experiment

- He cultured chloroplast containing differentiated cells from leaves of *Lamium purpureum* in Knop's solution in hanging drop cultures.

Results

- The cells grew in size but did not undergo any cell divisions. eventually the cultures were lost to infection.
- He failed largely because of his unfortunate choice of experimental material, and because of inadequacy of nutrition provided by Knop's salt solution.

Predictions made by Gottlieb Haberlandt

- He advocated the use of embryo sac fluids (Coenocytic liquid endosperm, such as coconut milk that was later used in tissue culture).
- Inducing cell divisions in vegetative cells.

Discovery of Plant Growth Substances

- Charles Darwin(1880) was one of the first to observe and describe the curvature of seedlings towards light.
- Effect could be prevented by covering the tip of the colioptile.
- The hormone later to be identified as naturally occurring auxin,IAA.

Auxins

- **Auxins** are a class of plant growth substance (often called phytohormone or plant hormone). Auxins play an essential role in coordination of many growth and behavioral processes in the plant life cycle.

Cytokinins

- In addition to auxins another compound is cytokinins having profound impact on the culture of isolated plant cells.
- They were discovered by Folk Skoog and his colleagues at the university of Wisconsin

The background is a vibrant green gradient, transitioning from a lighter green at the top to a darker green at the bottom. In the upper right corner, there are several bright green, glossy leaves, possibly from a plant like a peace lily, which are slightly out of focus. The overall aesthetic is clean and natural, suggesting a biological or environmental theme.

Genetic Transformation

Genetic Transformation

A process by which the genetic material carried by an individual cell is altered by the incorporation of foreign (exogenous) DNA into its genome.

Genetic Transformation

- Genetic Transformation was discovered by chance not by design by Frederick Griffith in 1928.
- He was trying to develop a vaccine for prevention of pneumonia epidemic.

Frederick Griffith Experiment

- Organism used was *Streptococcus pneumoniae*
- He used two different strains of *Streptococcus pneumoniae*
- *R strain (Rough type)*
- *S strain (Smooth type)*

Griffith's Experiment

- He injected mice with R strain and S strain.
- The mice injected with S strain develop pneumonia and died after few days, while those infected with R strain remains healthy.
- Mice injected with a mixture of inactivated S strain and normal R strain developed pneumonia.

Griffiths Results

- He postulated that some unknown “Transforming Principle” from the inactivated S strain had converted the non-capsulated non-virulent R strain into encapsulated and virulent S strain.

Purpose of Genetic Transformation

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- To improve the quality of crops
- To improve the productivity of crops in order to meet increasing demands of food.