IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

"Growth And Evolutions Of Tissue Culture In India And It's Benifits"

Name: BHANUSHREE B M

Meaning of Tissue Culture: Tissue culture, a method of biological research in which fragments of tissue from an animal or plant are transferred to an artificial environment in which they can continue to survive and function. The cultured tissue may consist of a single cell, a population of cells, or a whole or part of an organ.

Tissue culture is highly important in India as it allows for the rapid production of large quantities of disease-free, high-quality plants of various crops, significantly boosting agricultural productivity, improving crop yields, enhancing export potential, and contributing to rural employment by providing a reliable source of planting material, particularly for crops like bananas, which are major contributors to the Indian economy; this is achieved through the process of micropropagation, where plants are multiplied rapidly in a controlled laboratory environment, irrespective of the season.

Abstract: Plant tissue culture, or the aseptic culture of cells, tissues, organs, and their components under defined physical and chemical conditions in vitro, is an important tool in both basic and applied studies as well as in commercial application. It owes its origin to the ideas of the German scientist, Haberlandt, at the beginning of the twentieth century. The early studies led to root cultures, embryo cultures, and the first true callus/tissue cultures. The period between the 1940s and the 1960s was marked by the development of new techniques and the improvement of those that were already in use. It was the availability of these techniques that led to the application of tissue culture to five broad areas, namely, cell behavior including cytology, nutrition, metabolism, morphogenesis, embryogenesis, and pathology, plant modification and improvement, pathogen-free plants and germplasm storage, clonal propagation, and product mainly secondary metabolite formation, starting in the mid-1960s. The 1990s saw continued expansion in the application of the in vitro technologies to an increasing number of plant species. Cell cultures have remained an important tool in the study of basic areas of plant biology and biochemistry and have assumed major significance in studies in molecular biology and agricultural biotechnology in the twenty-first century. The historical development of these in vitro technologies and their applications is the focus of this chapter.

Key words: Disease-free plants, Rapid multiplication, Crop improvement, Conservation of endangered species, Economic impact, Employment generation, Export potential, Benefits, Production of compounds, Tissue transplant compatibility, State Wise Tissue Culture Centers In India.

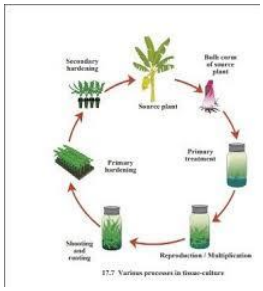
KINDS OF TISSUE CULTURE:

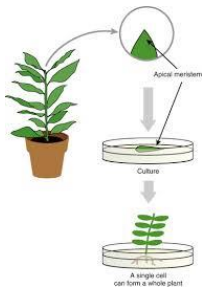
- **Callus culture**:- Involves growing an unorganized mass of cells from explants.
- **Single cell culture:-** Uses techniques like root tip culture to obtain clones from a single cell.
- **Anther culture:-** Uses pollen from the anther, the pollen-bearing part of the stamen, to produce plants.
- **Cell suspension culture:-** Uses liquid culture suspensions to grow cells. There are two types of suspension cultures: batch culture and continuous culture.
- **Hepatocyte tissue culture:-** Involves culturing hepatocytes, which play a role in metabolizing drugs, nutrients, and other constituents.

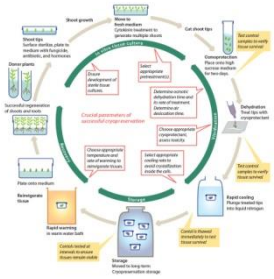
Gottlieb Haberlandt: Is known as the father of plant tissue culture. He was an German botanist, who was the first to separate and culture the plant cells on knop's salt solution. He pointed out for the first time that plants cells are totipotent, which led to establishment of plant tissue culture.

Father of Tissue Culture In India:

Maheshwari started work on tissue culture in the 1950s at the University of Delhi, where he worked in the Department of Botany. In the 1960s, the Botany School at the University of Delhi, led by Maheshwari, became actively engaged in in vitro culture of reproductive organs of flowering plants. Maheshwari was also known as the father of embryology in India. He was a Fellow of the Royal Society FRS in 1965, the second Indian Botanist to receive this accolade. Tissue culture is an artificial method that involves growing plant cells, tissue, or organs in nutrient solutions under controlled lab conditions. The term "tissue culture" was coined by American pathologist Montrose Thomas Burrows.







The aims and objectives of tissue culture:

- **Producing disease-free plants:** Tissue culture can produce high-quality, disease-free plants that are uniform and can be planted on a large scale.
- **Conserving plant biodiversity:** Tissue culture can be used to produce endangered plants.
- **Studying cell behavior:** Tissue culture can be used to study cell behavior, including cytology, nutrition, metabolism, and more.
- **Genetic modification:** Tissue culture can be used to genetically modify plants to produce desirable characteristics.
- **Producing artificial seeds:** Tissue culture can be used to produce artificial seeds, which can be used to germinate without elaborate in vitro handling.
- **Identifying infections and chromosomal abnormalities:** Tissue culture can be used to identify infections, enzyme deficiencies, and chromosomal abnormalities.

- **Formulating and testing drugs and vaccines:** Tissue culture can be used to formulate and test drugs and vaccines.

Tissue culture is a technique that involves growing plants on nutrient-rich growth substrates that are free of microbes. It's a straightforward technique that can be applied in developing countries.

- **Disease-free plants:** Tissue culture enables the propagation of plants free from viral and other diseases, leading to healthier crops and higher yields.
- **Rapid multiplication:** This technique allows for the rapid production of large numbers of identical plants from a single source, enabling faster propagation of desirable varieties.
- **Crop improvement:** Tissue culture is used to develop new crop varieties with improved traits like stress tolerance, high nutritional value, and enhanced yield potential.
- **Conservation of endangered species:** Rare and threatened plant species can be propagated through tissue culture to prevent their extinction.
- **Economic impact:** By producing high-quality planting material, tissue culture contributes significantly to the agricultural sector, boosting farmer incomes and improving food security.
- **Employment generation:** Tissue culture labs in rural areas provide employment opportunities, particularly for women, contributing to socio-economic development.
- **Export potential:** India has leveraged tissue culture to produce high-quality plants for export markets, particularly in the case of fruits like bananas.

Tissue culture is a technique that has many benefits:

- **Disease-free plants:** Tissue culture can produce disease-free plants.
- **Fast production:** Tissue culture can produce thousands of plantlets from a small amount of plant tissue in a short time.
- **Year-round growth:** Plants grown using tissue culture can be grown throughout the year, regardless of the season.
- **Small space:** Tissue culture requires little space to grow plants.
- **Ornamental plants:** Tissue culture is used to produce ornamental plants like orchids, chrysanthemums, and dahlias.
- **Crop improvement:** Tissue culture can improve crops by creating genetic variability, which can lead to disease-free plants with improved health and increased yields.
- **Rare plant species:** Tissue culture can be used to protect rare plant species.
- **Crossing species:** Tissue culture can aid in crossing species that are not closely related.
- **Production of compounds:** Plant cells can be developed in liquid culture to produce compounds like recombinant proteins and secondary metabolites.
- **Virus detection:** Tissue culture can be used to detect viruses like enteroviruses and rotaviruses.
- **Vaccine production:** Tissue culture has been used to produce vaccines against diseases like poliomyelitis, influenza, measles, and mumps.
- **Hormone production:** Hormones can be produced from tissue culture.

- **Tissue transplant compatibility:** Cultured white blood cells from two individuals can be used to determine compatibility for tissue transplants.
- **Chromosomal defects:** Tissue culture can be used to detect chromosomal defects in a fetus.
- Plant tissue culture is the aseptic culture of cells, tissues, organs and their components under defined physical and chemical conditions in vitro.
- The theoretical basis for plant tissue culture was proposed by Gottlieb Haberlandt in his address to the German Academy of Science in 1902 on his experiments on the culture of single cells.
- Historically, Henri-Louis Duhamel du Monceau 1756 pioneered the experiments on wound healing in plants through spontaneous callus unorganized mass of cells formation on decorticated region of elm plants.
- Vochting 1878 suggested the presence of polarity as a key feature that guide the development of plant fragments.
- He observed that the upper portion of a piece of a stem always produced buds and the basal region produced callus or roots.
- In 1902, a German Botanist Gottlieb Haberlandt developed the concept of culture of isolated cells of Tradescantia in artificial condition. Though his experiment failed to induce the cells to divide.
- He did not succeed because by that time even auxin was not discovered. But he lent a foundation to plant physiology.
- He described the cultivation of mesophyll cells of Lamium purpureum and Eichhornia crassipes, epidermal cells of Ornithogalum and hair cells of Pumonaria
- Cell survived for 3-4 weeks. Due to this endeavour, Haberlandt is regarded as the father of tissue culture. Most importantly he suggested the concept of totipotency.
- From 1902 to 1930 attempts were made for organ culture. Hannig 1904 isolated embryos of some crucifers and successfully grew on mineral salts and sugar solutions.
- Simon 1908 successfully regenerated a bulky callus, buds, roots from a poplar tress on the surface of medium containing IAA which proliferated cell division.
- The two important discoveries made in the mid- 1930s which gave a big push to the development of plant tissue culture technique were: (a) identification of auxin as a natural growth regulator, and (b) recognition of the importance of B-vitamins in plant growth.
- In 1934, Gautheret had cultured cambium cells of some tree species Salix capraea, Populus nigra on Knop's solution containing glucose and cysteine hydrochloride and recorded that they proliferated for a few months.
- The first true plant tissue cultures were obtained by Gautheret from cambial tissue of Acer pseudoplatanus.
- He also obtained success with similar explants of Ulmus campestre, Robinia pseudoacacia, and Salix capraea using agar-solidified medium of Knop’s solution, glucose and cysteine hydrochloride.
- The first continuously growing tissue cultures from carrot root cambium were established by Gautheret in 1939.
- White 1939a reported the establishment of similar cultures from tumour tissue of the hybrid Nicotiana glauca x N. langsdorffii.
- Then the possibility for cultivation of plant tissues for unlimited period was announced simultaneously by P.R. White 1939 and R.J. Gautheret 1939.

- Gautheret and White during 1930-40 were responsible for establishing the media composition we use today Subsequent detailed work by Raghavan and Torrey 1963, Norstog 1965 and others led to the development of synthetic media for the culture of younger embryos.
- During 1940 to 1970, suitable nutrient media were developed for culture of plant cells, tissue, protoplasts, anthers, roots tips and embryos.
- In vitro morphogenesis regeneration of complete plant from cultured tissue of plants was always successfully done.
- In 1957, Skoog and Miller put forth the concept of hormonal control of organ formation.
- Murashige was instrumental in giving the techniques of in vitro culture a status of a viable practical approach to propagation of horticul- tural species. He worked extensively for the popularization of the technique by developing standard methods for in vitro propagation of several species ranging from ferns, to foliage, flower and fruit plants.
- In 1959, discovery of kinetin promoted by F. Skoog along with C.O. Miller and co-workers and demonstration of induction of regeneration of shoots in tobacco callus paved the way for multiplication of plant by tissue culture.
- In 1960s, E. Cooking for the first time developed a method for isolation of protoplasts in large quantities using the fungal enzyme obtained from Myrothecieum sp.
- In 1960 Jones et al. designed a microculture method for growing single cells in hanging drops in a conditioned medium.
- The first plant from a matured plant cell was regenerated by Braun in 1959.

HISTORY OF INDIAN TISSUE CULTURE

- In India, work on tissue culture was started during mid 1950s at the Department of Botany (University of Delhi) by Panchanan Maheshwari who is regarded as father of embryology in India.
- During 1960s the Botany School at the University of Delhi, led by P. Maheshwari, became actively engaged with in vitro culture of reproductive organs of flowering plants.
- Kanta, 1960 developed the technique 'intra-ovarian pollination' and 'test-tube fertilization'.
- Different tissue culture methodologies were involved for morphogenic studies involving ovary, embryo, endosperm, ovules, etc.
- At the University of Delhi, Sipra Guha Mukherjee and S.C. Maheshwari 1964-67 for the first time developed the haploid through anther and pollen cultures.
- Haploid plants from pollen grains were first produced by Maheswari and Guha in 1964 by culturing anothers of Datura.

Other importance events in the history of plant tissue culture:

- 1926: Went discovered the first plant hormone, indole acetic acid.
- 1934: White added Vitamin B to the media, which helped develop embryo culture.
- 1971: Heinz and Mee reported somaclonal variation in the regenerants from callus cultures of sugarcane.
- 1972: Carlson et al. produced the first somatic hybrids by fusing isolated protoplasts of Nicotiana glauca and N. langsdorffii.
- 1978: Melchers and colleagues produced "Pomato", a hybrid of potato and tomato, through somatic hybridization.

STATE WISE TISSUE CULTURE CENTERS IN INDIA

Sl No	Name of TCPF	State	Production Capacity (In Millions)	Validity Date
1	Aastha Nursery	CHHATTISGARH	1	31-08-2026
2	ABC Agrobiotechnology Pvt. Ltd., Mahemdabad, Gujarat	GUJARAT	4	15-07-2026
3	ACE Agro Technologies	TELANGANA	8	18-07-2025
4	Advent Plantech LLP	MAHARASHTRA	25	26-04-2025
5	AG Bioteck Laboratories India Limited	TELANGANA	2.5	28-07-2026
6	Agri Vitro Tech Laboratories	TELANGANA	3	23-02-2025
7	Ajeet Seeds Pvt. Ltd.	MAHARASHTRA	20	10-02-2025
8	AKF PlantSciences Pvt. Ltd.	CHHATTISGARH	2	19-03-2025
9	Akshamaala Solution Pvt. Ltd.	UTTAR PRADESH	2	07-07-2026
10	Almaq Biotech LLP	MAHARASHTRA	2	28-02-2025
11	Arihanth Biotech	MADHYA PRADESH	1.5	28-02-2025
12	Arya Biotech	MAHARASHTRA	1	07-07-2026
13	Atul Rajasthan Date Palms Ltd.	RAJASTHAN	0.5	07-04-2026
14	Avika Water Solutions	PUNJAB	1	07-07-2026
15	Bhatti Tissue Tech	PUNJAB	0.65	25-06-2025
16	Biosis Plants Pvt. Ltd.	MAHARASHTRA	2.5	19-06-2026
17	Callus Biotech Pvt. Ltd.	MAHARASHTRA	2	20-08-2026
18	Center for Plant Tissue Culture & Vegetative Propagation	ANDHRA PRADESH	1	28-07-2026
19	COE AIB Tissue Culture Lab IGKV Raipur	CHHATTISGARH	1	14-08-2026
20	Devleela Biotechs	CHHATTISGARH	3.2	19-03-2025
21	Elegant Flower Company Pvt. Ltd.	WEST BENGAL	2.5	03-03-2025
22	Elite Biotechnologies	ANDHRA PRADESH	2.5	05-10-2025
23	Excel Plant Link Pvt. Ltd. Unit-2	ODISHA	3	10-05-2025
24	FLORANCE FLORA FARM	KARNATAKA	2.5	16-09-2026
25	Futura Bioplants Pvt. Ltd.	MAHARASHTRA	45	10-06-2026
26	Genewin Biotech	TAMIL NADU	2	05-10-2025
27	GNFC Tissue Culture Laboratory	GUJARAT	1.5	19-05-2026
28	Golden Tree Agroforest Pvt. Ltd.	CHHATTISGARH	2	21-10-2026
29	Green India Champion Agro Pvt. Ltd.	MAHARASHTRA	0.7	07-07-2026
30	Green Leaf Plant Technology	KARNATAKA	3	03-05-2026
31	Greenfield Biotech, Gandhinagar	GUJARAT	0.51	26-03-2024
32	Growmore Biotech Ltd.	TAMIL NADU	10	22-05-2026
33	GRS Bioplants Pvt. Ltd.	UTTAR PRADESH	0.55	19-07-2024
34	H. U. Gugle Agro Biotech Co.	MAHARASHTRA	3	22-05-2026
35	Heartfulness Institute	TELANGANA	1.5	28-07-2026
36	Hecure Agro Plants Pvt. Ltd.	BIHAR	2.5	15-05-2025
37	HiFi Biotech India Pvt. Ltd.	TAMIL NADU	0.75	05-10-2025
38	Hosur Hortitech	TAMIL NADU	1	01-04-2024
39	HU Gugle Biotech Pvt. Ltd., Bangalore	KARNATAKA	3	07-05-2026
40	IRM Enterprises Pvt. Ltd.	GUJARAT	10	22-09-2024
41	Ishved Biotech Pvt. Ltd.	MAHARASHTRA	5	28-02-2025
42	Jagadamba Bio Plants	KARNATAKA	1.5	03-10-2024
43	JAIN IRRIGATION SYSTEMS LIMITED	MAHARASHTRA	100	10-06-2026
44	Janani Biotech & Tissue Culture Lab	MAHARASHTRA	0.9	28-02-2025
45	Jayasree Biotech	TAMIL NADU	1	30-04-2025

46	Kalpataru Agro Biotech	GUJARAT	3	28-02-2025
47	KF Bioplants Pvt. Ltd.	MAHARASHTRA	32	15-08-2026
48	KF Biotech Pvt. Ltd.	KARNATAKA	8	07-03-2025
49	Kimya Biotech Pvt. Ltd.	MAHARASHTRA	0.5	29-05-2026
50	Kutch Crop Services Pvt. Ltd.	GUJARAT	0.5	10-06-2026
51	M/S CELGEN BIOTECH INDIA	MADHYA PRADESH	2	19-07-2025
52	Magadh Sugar & Energy Ltd. (Unit N. S. S. Mills)	BIHAR	0.5	12-06-2025
53	MAHABEEJ BIOTECHNOLOGY CENTER	MAHARASHTRA	0.5	17-05-2025
54	Mahindra HZPC Pvt. Ltd.	PUNJAB	6	12-06-2024
55	Maltbio Agri Pvt. Ltd.	GUJARAT	2	21-05-2026
56	MANU'S LABS	GUJARAT	0.5	12-05-2024
57	Merino Industries Ltd.	UTTAR PRADESH	1.2	02-03-2025
58	Meristem Biotech	KARNATAKA	4	05-10-2025
59	Metrogen Biotech Pvt. Ltd.	GUJARAT	2.5	23-08-2026
60	Micco Laboratories Private Limited, Chittor	ANDHRA PRADESH	0.5	06-02-2024
61	Microsun Bioplants India Pvt. Ltd.	TELANGANA	2	09-04-2025
62	Mysore Organic Farms Pvt. Ltd.	KARNATAKA	3	23-04-2024
63	Namo Bioplants	MAHARASHTRA	3	10-05-2026
64	Narmada Phosphate Ltd.	CHHATTISGARH	1	19-04-2025
65	Nation Agri Biotech	GUJARAT	2.5	12-05-2026
66	Natural Life Sciences	GUJARAT	2	23-11-2025
67	Nishant Biotech	HIMACHAL PRADESH	1.5	15-07-2026
68	Novel Biotech, Bengaluru	KARNATAKA	4.5	06-02-2026
69	NUMICS BIOTECH	GUJARAT	2.5	16-05-2026
70	Palaj Agrotech, Gandhi Nagar	GUJARAT	1.5	26-03-2024
71	Pallishree Ltd.	WEST BENGAL	1.5	19-04-2025
72	PepsiCo India Holdings Pvt. Ltd.	HARYANA	1	28-02-2025
73	Pratham Enterprises (Plant Tissue Culture Unit)	UTTAR PRADESH	3	28-07-2026
74	Ram Biotech	MAHARASHTRA	2	23-11-2025
75	Regional Plant Resource Centre	ODISHA	0.6	04-08-2024
76	Reva Flora Culture	MADHYA PRADESH	6	05-07-2026
77	Rise N Shine Biotech Pvt. Ltd.	MAHARASHTRA	40	19-09-2024
78	Sachdev Nursery	MADHYA PRADESH	4	11-04-2025
79	Sagar Agrisciences Pvt. Ltd. (Unit-II)	UTTAR PRADESH	0.5	15-05-2025
80	SAI SHAKTI BIO TECHNOLOGY	CHHATTISGARH	0.8	21-10-2026
81	Sarjan Biotech Pvt. Ltd.	GUJARAT	3	13-05-2026
82	Sashanka Agro Tech Private Limited	JHARKHAND	10	31-08-2026
83	Seema Biotech Pvt. Ltd.	MAHARASHTRA	3	31-08-2026
84	Seven Star Fruits Pvt. Ltd.	MAHARASHTRA	0.95	30-03-2026
85	Shaanthi Agrotech	KARNATAKA	1	17-01-2025
86	Sharma Biotech Agrigold Pvt. Ltd.	HIMACHAL PRADESH	1	12-06-2025
87	Sheel Biotech Ltd.	HARYANA	10	06-07-2026
88	Shree Abhimanyu Biotech	GUJARAT	1	14-08-2025
89	Shree Ganesh Khand Udyog Sahakari Mandli Limited	GUJARAT	0.5	27-05-2026
90	Shri Mukund Biotech	MADHYA PRADESH	2.5	28-02-2025
91	Siddhi Plantek	GUJARAT	2	19-03-2025

92	SLR Greentech Pvt. Ltd.	KARNATAKA	5	22-06-2024
93	SPIC Agro Biotech Centre	TAMIL NADU	7	22-09-2024
94	Sree Adithya Biotech	KARNATAKA	4.2	05-10-2025
95	Sree Bairava Nursery	TAMIL NADU	2.5	04-08-2024
96	Sri Ratnam Biotech LLP	GUJARAT	2.5	19-04-2026
97	Sri Soma Biotech	ANDHRA PRADESH	0.5	19-10-2024
98	SV Kisan Biotech	MAHARASHTRA	0.6	07-07-2026
99	Technico Agri Sciences Ltd. (Chambal Agritech Ltd.)	CHANDIGARH	16.5	06-06-2026
100	The Energy and Resources Institute (TERI)	DELHI	2	17-05-2026
101	Tirupati Fresh Agro Crop Science Pvt. Ltd.	MADHYA PRADESH	2.5	07-05-2025
102	Tissue Culture Laboratory (CoE Potato)	PUNJAB	0.5	15-05-2025
103	V2 PLANTS INC	KARNATAKA	1	05-10-2025
104	Vasundhara Biotech	MAHARASHTRA	0.6	07-07-2026
105	Verdant bioAgri LLP	KARNATAKA	5	28-07-2026
106	Vitrigold Biotech Pvt. Ltd.	GUJARAT	2.5	07-04-2026
107	Vitroplant	TELANGANA	10	09-03-2025
108	Warana Biotech LLP	MAHARASHTRA	0.5	07-07-2026
109	Yash Biotech	CHHATTISGARH	0.5	31-10-2024

Conclusion: Tissue culture is one of scientific technical of growth of high yield in plantation, agriculture, sericulture and other production activates. Plant tissue culture as an important tool for the continuous production of active compounds including secondary metabolites and engineered molecules. Novel methods gene editing, abiotic stress can improve the technique. The program has helped improve the livelihoods of farmers by increasing their incomes. Many tissue culture facilities are located in remote areas, providing employment for the local rural population. The program has contributed to the overall betterment of society by increasing farmers' incomes, boosting exports, and generating rural employment. Tissue culture has helped conserve endangered plant species. Tissue culture has helped boost herb exports by three times in recent years. The Indian Agricultural Research Institute IARI has released new grape varieties for wine, juice, raisin making, and table purposes.

Bibliography:

1. Gautheret, R. J. 1939 Sur la possibilité de réaliser la culture indéfinie des tissusde tubercules de carotte. C.R. Hebd. Seances Acad. Sc. 208, 118–120.
2. 17. Nobécourt, P. 1939 Sur la pérennité et l'augmentation de volume des cultures de tissues végétaux. C.R. Seances Soc. Biol. Ses Fil. 130, 1270–1271.
3. 18. White, P. R. 1939 Potentially unlimited growth of excised plant callus in an artificial nutrient. Am. J. Bot. 26, 59–64.
4. Nobécourt, P. 1939 Sur les radicelles naissant des cultures de tissus végétaux. C.R. Seances Soc. Biol. Ses Fil. 130, 1271–1272.
5. White, P .R. 1939 Controlled differentiation in a plant tissue culture. Bull. Torrey Bot. Club 66, 507–513.
6. White, P. R. 1963 The Cultivation of Animal and Plant Cells, 2nd ed., Ronald Press, New York.
7. Bhojwani, S. S. and Razdan, M. K. 1983 Plant Tissue Culture: Theory and Practice. Developments in Crop Science, Vol. 5. Elsevier, Amsterdam.
8. Gautheret, R. J. (1985) History of plant tissue and cell culture: A personal account, in Cell Culture and Somatic Cell Genetics of Plants Vasil, I. K., Vol. 2, Academic Press, New York, pp. 1–59.
9. Thorpe, T. A. 2000 History of plant cell culture. Chap. 1, in Plant Tissue Culture: Techniques and Experiments, Smith, R. H., ed. 2nd ed., Academic Press, California, pp. 1–32. With permission

from Elsevier.
10. Van Overbeek, J., Conklin, M. E., and Blakeslee, A. F. 1941 Factors in coconut milk essential for growth and development of very young Datura embryos. Science 94, 350–351.
11. Gautheret, R. J. 1942 Hétéro-auxines et cultures de tissus végétaux. Bull. Soc. Chim. Biol. 24, 13–41.
12. Gautheret, R. J. 1955 Sur la variabilité des propriétés physiologiques des cultures de tissues végétaux. Rev. Gén. Bot. 62, 5–112.
13. Nobécourt, P. 1955 Variations de la morphologie et de la structure de cultures de tissues végétaux. Ber. Schweiz. Bot. Ges. 65, 475–480.
14. Skoog, F. and Tsui, C. 1948 Chemical control of growth and bud formation in tobacco stem segments and callus cultured in vitro. Am. J. Bot. 35, 782–787.
15. Miller, C., Skoog, F., Von Saltza, M. H., and Strong, F. M. 1955 Kinetin, a cell division factorfrom desoxyribonucleic acid. J. Am. Chem. Soc. 77, 1392. Kohlenbach, H. W. 1966 Die Entwicklungspotenzen explantierter und isolierter Dauerzellen. I. Das Strechungs- und Teilungswachstum isolierter Mesophyllzellen von Macleaya cordata Z. Pflanzenphysiol. 55, 142–157.
16. Tulecke, W. and Nickell, L. G. 1959 Production of large amounts of plant tissue by submerged culture. Science 130, 863–864.
17. Vasil, V. and Hildebrandt, A. C. 1965 Differentiation of tobacco plants from single, isolated cells in micro cultures. Science 150, 889–892.
18. Heller, R. 1953 Recherches sur la nutrition minerale des tissus végétaux cultivé in vitro. Ann. Sci. Nat. Bot. BioI. Veg. 14, 1–223.
19. Nitsch, J. P. and Nitsch, C. 1956 Auxin-dependent growth of excised Helianthus tuberosus tissues. Am. J. Bot. 43, 839–851.
20. Morel, G. and Martin, C. 1952 Guérison de dahlias atteints d'une maladie á virus. C.R. Hebd. Seances Acad. Sc. 235, 1324–1325.
21. Quack, F. 1961 Heat treatment and substances inhibiting virus multiplication in meristem culture to obtain virus-free plants. Adv. Hortic. Sci. Their Appl., Proc. Int. Hortic. Congr. 15th, 1958 1, 144–148.
22. Internet sources, Daily Newspapers, Conference and class meterials, etc.