The pioneer work on culture of plant cells and tissues was started by Haberlandt (1902). He was the first person to culture isolated vegetative cells of higher plants in simple nutrient solutions. Embryos were first plant tissue to be successfully cultured \textit{in vitro} on artificial media. Hanning (1904) successfully cultured embryos of \textit{Raphanus sativus, R. landra, R. caudatus} and \textit{Cochlearia danica} on Tollén’s medium and obtained transplantable seedlings. White (1934) was the first to achieve success in continuously growing cultures of tomato root tips using sucrose, inorganic salt and yeast extract. Gautheret (1934) cultured cambium cells of some tree species viz Willow (\textit{Salix capraea}) and poplar (\textit{Populus nigra}) on Knop’s solution. White (1939) demonstrated the potentially unlimited growth of excised tomato root tips \textit{in vitro} culture. Work of Gauthret, White and Nobecourt (1939) laid the foundation for further work in the field of plant tissue culture. The tissue culture media, presently in use were modifications of those established by these three pioneers.

Van Overbeek \textit{et al.} (1941) demonstrated for the first time the stimulatory effect of coconut milk on embryo development and callus formation in \textit{Datura}. Skoog (1944) and Skoog and Tsui (1951) demonstrated that in tobacco pith tissue cultures, the addition of adenine and high levels of phosphate increased callus growth and bud formation even in the presence of IAA which otherwise acted as bud-inhibitor. Morel and Martin (1952) for the first time developed the method for obtaining virus-free \textit{Dahlia} plants from diseased individuals by culturing healthy shoot tips. Muir (1953) reported that by transferring callus tissue of \textit{Tagetus} and \textit{Nicotiana} to liquid medium and agitating the cultures on a shaking medium, it was possible to obtain single cells. Muir \textit{et al.} (1954) further cultured single cells by nurse culture method and observed cell division. Skoog and Miller (1957) put forth the concept of hormonal control of organ formation. They showed that the differentiation of roots and shoots in tobacco pith tissue cultures was a function of the auxin-cytokinin ratio. Formation of somatic embryos from tissue of carrot was reported by Reinert (1958, 1959) and Steward (1958).
Morel (1960) obtained virus free orchid plants by the technique of tissue culture. Murashige (1961) demonstrated the usefulness of the technique of in vitro culture for propagation of various plant species. A medium for rapid growth of tobacco tissue in vitro was developed by Murashige and Skoog (1962), popularly known as MS medium, which is one of the most widely used salt compositions for the purpose of plant regeneration now a days. Guha and Maheshwari (1964, 1966) reported development of embryos from pollen grains in anther culture of Datura innoxia. Vasil and Hildebrandt (1965) demonstrated that a single isolated cell can divide and ultimately give rise to whole plant in Nicotiana. Mitra et al. (1965) reported callus formation from excised roots, stems, leaves and cotyledons of Rauvolfia serpentina on White’s and MS medium supplemented with coconut milk and 2,4-D. Bourgin and Nitsch (1967) using Nicotiana anthers observed that the pollen embryos developed directly into haploid plants. The origin and development of callus in Salvadora persica has been studied by Kant and Arya (1967). Mitra (1968) studied the growth of isolated roots of R. serpentina in a modified White’s nutrient solution. Rao and Mehta (1969) raised the callus from the pollen of Thuja orientalis on White’s medium supplemented with casein hydrolysate, coconut milk and 2,4-D.

Nagata and Takebe (1971) described for the first time, the regeneration of entire plantlets from mesophyll protoplasts of Nicotiana tabacum. Chandy and Narayanswami (1971) reported production of pollen embryoids and plantlets through culture of immature anthers of Datura metel on a simple nutrient medium supplemented with coconut milk. Ghugale et al. (1971) studied the effect of auxins and gibberellic acid on growth and differentiation of Morus alba and Populus nigra tissues in vitro. Narayanaswamy and George (1972) developed the plantlets of Atropa belladonna from pollen through anther culture on MS medium. Mitra (1972) achieved the continuous culture of excised Atropa belladonna roots on a modified Street and McGregor’s solution in dark. The callus growth of Cucumis melo on White’s medium was achieved by Fadia and Mehta (1973). Sadhu (1974) studied the effect of different auxins on growth and differentiation in callus of sunflower stem pith. Sehgal (1975) cultured the leaf and petiole segments of Begonia semperflorens on modified White’s basal medium supplemented with various growth regulators. The root callus of Citrus aurantifolia in continuous culture was established by Chaturvedi and Chowdhury (1975). Corduan and
Spix (1975) reported production of haploid callus and regeneration of plants from anthers of *Digitalis purpurea*. Corduan (1975) also developed a method for production of anther-derived plants of *Hyoscyamus niger*. Mascarenhes *et al.* (1976) compared growth of callus of *Dioscorea deltoidea* on three media (White’s, Smith’s and MS medium).

Reddy and Narayana (1977) cultured the hypocotyl segments of *Vigna sinensis* on modified White’s medium supplemented with NAA and Kn. Grewal *et al.* (1977) attempted the apical meristem culture in *Dioscorea deltoidea*. Bapat and Narayanaswami (1977) studied the nutritional and hormonal requirements for the growth of callus derived from mesocarp and endocarp tissue of *Achras sapota*. A method for plant regeneration *in vitro* from shoot tips and callus of Papaya was developed by Yie and Liew (1977). Ramawat and Arya (1977) studied the effect of carbohydrate on callus culture of *Ephedra gerardiana* and *E. foliata* on MS medium. Sharma and Chowdhury (1977) raised the callus and embryoids from anthers of *Datura innoxia* cultured on Nitsch medium containing coconut milk. Khanna *et al.* (1977) studied the effect of cholesterol on *in vitro* suspension cultures of *Costus speciosus*, *Dioscorea floribunda* and *Solanum aviculare*.

Shah and Mehta (1978a) suggested that the availability of sucrose was one of the limiting factors in the synthesis of phenolic compounds in callus culture of *Crotalaria* sp. Shah and Mehta (1978b) studied the effect of nitrogen nutrition on growth and phenolic accumulation in culture of *Crotalaria*. Chaturvedi and Sinha (1979) succeeded in *in vitro* mass clonal propagation of *Solanum khasianum*. Grewal *et al.* (1979) raised the static cultures of *Hyoscyamus muticus* from apical shoot tips and studied the effect of environmental condition and growth regulators on growth, organogenesis and alkaloid production. Narayanaswamy and Prabhudesai (1979) cultured the tuberous root, bracts and petals of the tuberose (*Polianthes tuberosa*) on MS medium containing 2,4-D and Kn and developed somatic pseudoembryogeny. Sukla and Gadgil (1979) raised fruit callus culture of *Solanum nigrum* on MS medium supplemented with coconut water and 2,4-D and studied the effect of purines, pyrimidines and growth regulators on bud differentiation.
Chaturvedi and Chowdhury (1980) observed that tuber callus of *Dioscorea deltoidea* showed prolific growth on a modified Schenk and Hildebrandt’s agar medium supplemented with 2,4-D and IAA. Work on micropropagation of *Glycyrrhiza glabra* has been done by Shah and Dalal (1980). Bajaj and Singh (1980) induced androgenesis in excised anthers of three Indian cultivars of *Phaseolus aureus* cultured on modified MS medium. Sita *et al.* (1980) reported embryogenesis in suspension culture of *Santalum album*, leading to plantlet formation. Multiple shoot formation has been reported in *Eucalyptus citriodora* by Grewal *et al.* (1980). Embryogenesis via inflorescence and nodal explant of *Lolium multiflorum in vitro* were achieved by Dale *et al.* (1981), Dalton and Dale (1981). Bhansali and Arya (1981) reported that *Crotalaria medicagenia* cultures required BAP and 2,4-D for the induction of an differentiated callus mass. Padmanabhan *et al.* (1981) described *in vitro* method of virus elimination and propagation of *Pogostemon cablin* from shoot tips and callus cultures.

Constabel *et al.* (1982) cultured callus derived from hypocotyls of periwinkle (*Catharanthus roseus*) and showed alkaloid production. Regeneration of multiple shoot buds has been observed in *Solanum khasianum* (Gunay and Rao, 1982) and *S. surattense* (Gupta and Chandra, 1982). Ahuja *et al.* (1982) clonally propagated four different *Ocimum* sp. from first four apical nodal segments on MS medium. A procedure for the *in vitro* clonal mass propagation of shoots and plants of two *Cinchona* species derived from single shoot tips was described by Koblietz *et al.* (1983). Gupta *et al.* (1983) reported clonal propagation of *Eucalyptus torelliana* and *Eucalyptus camaldulensis* through nodal explants of mature trees.

Tamura *et al.* (1984) clonally propagated *Stevia rebaudiana* by culturing stem tips with a few leaf primordia on agar medium supplemented with a high concentration of Kn. Sharma *et al.* (1984) established callus cultures on modified MS medium from axillary buds and shoot tips of *Phoenix dactylifera*. Organogenesis and tuberization in cultures of *Dioscorea floribunda* was developed by Gupta *et al.* (1984). Goyal and Arya (1984) studied nutritional requirements for maximum shoot differentiation and growth from single bud culture of *Prosopis cineraria*. Callus culture and *in vitro* regeneration from bulb explants of diploid *Urginea indica* on modified MS medium was achieved by Jha *et al.* (1984).


indigenous variety of Tobacco (*Nicotiana tabacum* var. Jayasri). Upadhyay *et al.* (1989) attempted *in vitro* propagation of *Picrorhiza kurroa*. Plant regeneration from different explants of *Capsicum annum* through tissue culture was reported by Agrawal *et al.* (1989). Bourque *et al.* (1989) employed young leaf and internodal stem segments of *Gaillardia pulchella* to initiate callus on MS medium containing NAA and BAP. Micropropagation of *Cinnamomum cassia* has been achieved by Inomoto and Kitani (1989). Kumar and Datta (1989) observed regeneration of plantlet from hypocotyl tissue of *Strychnos nuxvomica*.

Balachandran *et al.* (1990) developed *in vitro* clonal multiplication of turmeric (*Curcuma* sp.) and ginger (*Zingiber officinalis*) via rhizome buds excised from respective plants. Hoekstra *et al.* (1990) described the effect of auxin on cytodifferentiation and production of quinoline alkaloid in compact globular structure of *Cinchona ledgeriana*. Inamdar *et al.* (1990) reported formation of somatic embryos via callusing from culture of shoot apices of adult *Crataeva nurvala* on MS medium containing 2,4-D. Plessner *et al.* (1990) succeeded in *in vitro* corm production in the saffron (*Crocus sativus*). Natali *et al.* (1990) established a rapid and highly effective method of propagating *Aloe barbadensis*, using meristem tip explants from mature vegetative plants. Investigations on micropropagation of *Hyoscyamus muticus* have been done by Giri and Ahuja (1990). Kopp and Nataraja (1990) observed that in *Tamarindus indica* shoot tips excised from *in vitro* grown seedlings regenerated into plantlets on MS medium containing IAA or IBA. Gharyal and Maheshwari (1990) observed that in *Cassia fistula* and *C. siamea*, stem and petiole explants formed callus and differentiated into shoot-buds. Micropropagation of *Azadirachta indica* was attempted by Ramesh and Padhya (1990).


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multiple shoots in apical and axillary meristems derived from seedlings of *Madhuca longifolia* on MS medium. *In vitro* callus induction and plant regeneration from leaf tissue in *Aralia elata* has been observed by Jhang *et al.* (1993).


was established for *Citrus sinensis* var. *mosambi* by Das *et al.* (1995). Protocol for *in vitro* micropropagation of *Eclipta alba* from nodal segment explant has been developed by Franca *et al.* (1995). Dasgupta and Bhattacharya (1995) achieved plant regeneration of *Bauhinia variegata*. Sharma and Singh (1995) successfully produced *in vitro* microrhizome of *Zingiber officinale* from tissue culture derived shoots by transferring them to liquid MS medium. Morphogenetic potential of different explants of three cultivated *Piper* sp.- *Piper longum* (pipli), *P. betel* (betel vine) and *P. nigrum* (black pepper) was investigated to develop a reliable plant regeneration protocol by Bhat *et al.* (1995).


In vitro propagation of Areca catechu via direct adventitious shoot bud differentiation from cotyledon explants on MS, White’s, Branton and Blake’s medium
was reported by Mathew and Philip (2000). Emmanuel et al. (2000) carried out in vitro propagation of Wedelia calendulacea using axillary and shoot tip explants. Shahzad and Siddiqui (2000) reported multiple shoots formation on nodal organogenic callus of Ocimum sanctum raised on 2, 4-D supplemented MS medium. Philomina and Rao (2000) reported bud break and multiple shoot induction in apical and axillary meristems of Sapindus mukorossi on MS medium. Protocols for the micropropagation of two medicinal plants Eclipta alba and Eupatorium adenophorum from nodal explants were developed by Borthakur et al. (2000). Arya et al. (2000) and Mathur et al. (2000) produced somatic embryos in Pinus roxburghii. Tiwari et al. (2000a) developed an efficient and rapid method using liquid shake culture for the in vitro propagation of Bacopa monniera. Tiwari et al. (2000b) induced enhanced axillary bud proliferation in nodal explants isolated from mature plant of Centella asiatica in vitro. Efficient plant regeneration systems via somatic embryogenesis have been developed for Acacia farnesiana and A. schaffneri by Ortiz et al. (2000). Rani et al. (2000) standardized an in vitro propagation protocol from rhizome explants of Acorus calamus. In vitro multiplication of Peganum harmala was achieved by Saini and Jaiwal (2000). Hoque et al. (2000) reported indirect organogenesis from cotyledons of Momordica dioica on MS medium fortified with BAP and NAA.

explants for micropropagation of *Plumbago zeylanica*. Nugent *et al.* (2001) obtained somatic embryos from cotyledon pieces and hypocotyls of mature embryos of *Eucalyptus globulus* cultured on media containing high concentration of picloram or IBA. Baruah *et al.* (2001) developed a protocol for high frequency plant regeneration in *Hypericum patulum* using shoot tip explants.


An efficient protocol has been developed for rapid mass propagation of *Tylophora indica* from leaf derived callus by Faisal and Anis (2003). Vengadesan (2003) developed *in vitro* propagation protocol for *Acacia sinuata* using nodal explants.

A plant regeneration protocol of *Andrographis paniculata* via somatic embryogenesis was achieved by Martin (2004a). High frequency plant regeneration was achieved on callus, derived from leaf (petiole and lamina) and internode explants of *Centella asiatica* by workers like Martin (2004b) and Paramageetham *et al.* (2004). A method of adventitious shoot regeneration and micropropagation using hypocotyls, cotyledon and cotyledonary nodal explants in *Calendula officinalis* was developed by

Bhaskaran and Jayabalan (2005) described an efficient, rapid and large scale in vitro clonal propagation method of the valuable medicinal herb Eclipta alba by enhanced axillary shoot proliferation. Plant regeneration via somatic embryogenesis was achieved in embryogenic callus cultures derived from immature zygotic embryos of Azadirachta indica by Rout (2005). A protocol for somatic embryogenesis in Acacia arabica was developed by Rout and Nanda (2005). Kumar et al. (2005) cultured Holarrhena antidysertera through nodal explants. Kannan et al. (2005) studied the morphogenetic potential of somatic explants (apical and nodal bud) and embryos of Withania somnifera on MS medium fortified with various growth substances. Kumari and Shivanna (2005) established a protocol for callus induction and in vitro regeneration of plantlets from calli of different explants of Desmodium oojeinense. A tissue culture propagation system was developed for Zedoary (Curcuma zedoaria) using rhizome sprout cultures by Loc et al. (2005). Protocol has been developed for high frequency shoot regeneration and plant establishment of
Tylophora indica from petiole derived callus by Faisal et al. (2005) and Anis and Faisal (2005). Echeverriagaray et al. (2005) achieved micropropagation of Lavandula dentata from axillary buds. A protocol for micropropagation of plants using axillary bud proliferation from nodal explants of Terminalia bellirica seedlings has been developed by Ramesh et al. (2005). A high frequency adventitious shoot regeneration was developed for henbane (Hyoscyamus niger) using Thidiazuron (TDZ) by Uranbey (2005).


Neibaur *et al.* (2008) studied the effect of DICAMBA; 2,4-D and BAP on callus induction and plant regeneration from immature inflorescence segments of seashore
Seshadri (2008) induced callus from leaf and nodal explants of *Vanilla planifolia* on MS medium supplemented with 2,4-D and NAA in combination with BAP.


Gour and Kant (2009) reported *in vitro* regeneration in *Emblica officinalis* from juvenile root-derived callus. Kumar *et al.* (2009) obtained shoots from callus derived from cotyledons of mature seeds of *Moringa oleifera* on MS medium supplemented with NAA, BAP and 2,4-D. An efficient *in vitro* regeneration protocol was developed for direct and indirect organogenesis using cotyledonary node explants of *Solanum melongena* by Khan *et al.* (2009). Li *et al.* (2009) induced somatic embryogenic callus and subsequently regenerated plants from mature caryopsis of two important forage and ornamental grasses, big bluestem (*Andropogon gerardii*) and little bluestem (*Schizachyrium scoparium*). Yuan *et al.* (2009) developed a plant regeneration system through callus from seeds of centipedegrass (*Eremochloa ophiuroides*). An efficient


Faizal et al. (2011) developed a method for micropropagation of four different medicinal Maesa species (M. argentea, M. balansae, M. lanceolata and M. perlarius) through both axillary bud formation and adventitious shoot regeneration from leaf
explants. Tan et al. (2011) carried out plant regeneration from juvenile leaf and nodal derived callus of a climbing orchid, *Vanilla planifolia*. Munoz-Concha and Davey (2011) achieved micropropagation of an endangered Chilean tree- *Gomortega keule*. Garcia et al. (2011) studied the influence of type of explant, plant growth regulators, salt composition of basal medium and light on callogenesis and regeneration in *Passiflora suberosa*. An efficient protocol has been developed for the *in vitro* propagation of a valuable woody medicinal plant *Pterocarpus santalinus* using shoot tip explants by Balaraju et al. (2011). Wadl et al. (2011) achieved plant regeneration from flower receptacles and leaf explants of *Pityopsis ruthii*. Al-Safadi and Elias (2011) carried out *in vitro* culture studies on caper (*Capparis spinosa*) using seeds, immature fruits and stem cuttings as explants and also studied the effect of gamma irradiation on the growth of caper shoots. Pelegrini et al. (2011) established a protocol for micropropagation of *Ocotea porosa* through axillary buds. Klerk and Brugge (2011) reported micropropagation of *Dahlia* in static liquid medium using slow-release tools of MS and Driver-Kuniyuki Walnut (DKW) medium ingredients. Dobranszki and Silva (2011) achieved adventitious shoot regeneration from leaf transverse thin cell layers (tTCLs) in two cultivars of apple (*Mallus sp.*). Savita et al. (2011) developed an efficient plant regeneration protocol from callus cultures of *Citrus jambhiri* using cotyledons as explants. They were used malt extract with different growth regulators. An efficient *in vitro* propagation and regeneration method via leaf and petiole explants of an endangered plant *Metabriggsia ovalifolia* was established by Ma et al. (2011). Cheruvathur and Thomas (2011) developed a method for callus induction and subsequent plantlet regeneration using cotyledonary node and young leaf pieces of *Pseudarthria viscida*. Krishna et al. (2011) carried out *in vitro* regeneration of pigeon pea (*Cajanus cajan*) through organogenesis and somatic embryogenesis. Joseph et al. (2011) developed efficient methods for both *in vitro* seed germination and micropropagation of an economically important dye yielding multipurpose tree, *Bixa orellana*. Siwach and Gill (2011) attempted an *in vitro* propagation protocol from nodal explants of *Ficus religiosa* on Woody plant medium and studied the effect of adenine sulphate, glutamine and phloroglucinol on shoot multiplication. Micropropagation of commercially cultivated Henna (*Lawsonia inermis*) using nodal explants has been achieved by Ram and Shekhawat (2011). Palmer and Keller (2011a) induced somatic
vernicillatum using stem disc explants was attempted by Bisht et al. (2012). Goyal et al. (2012) established a protocol for micropropagation of *Pithecellobium dulce* via nodal explants and assessed the genetic fidelity of micropropagated plants using molecular markers. Parmar et al. (2012) developed *in vitro* plant regeneration protocol for ten commercial Indian bread wheat (*Triticum aestivum*) cultivars using mature embryos as explants. An improved *in vitro* propagation method has been developed for *Terminalia bellirica* from nodal explants (Phulwaria et al., 2012). Thangjam and Sahoo (2012) achieved *in vitro* regeneration of *Parkia timoriana* using cotyledonalry nodal explants.