

LIST OF FIGURES

Fig. No.	Figure Content
2.1	<i>Artemisia vulgaris</i> Linn. – Medicinal herb
2.2	<ul style="list-style-type: none"> a. Leaf callus of <i>A. vulgaris</i> on MS + 2,4-D (1.0 mg l⁻¹) b. Scanty callus on MS+ 2,4-D (1.5mg l⁻¹) c. Soft, yellowish and friable callus from the leaf segments on MS + NAA (1.5 mg l⁻¹) d. Callus of <i>A. vulgaris</i> on MS + BAP (2.0 mg l⁻¹) from leaf nodular. e. Embryogenic and light white to green callus of <i>A. vulgaris</i> on MS + BAP (1.5 mg l⁻¹)
2.3	<ul style="list-style-type: none"> a. Greenish, hard, nodular and embryogenic callus of <i>A. vulgaris</i> on MS + BAP (0.5 mg l⁻¹) b. Luxuriant embryogenic callus on MS + BAP (3.0 mg l⁻¹) and NAA (0.5mg l⁻¹) c. Luxuriant embryogenic callus on MS + BAP (1.0 mg l⁻¹) and GA₃ (3.0 mg l⁻¹) d. Luxuriant callus on MS + BAP (0.5 mg l⁻¹) and 2,4-D (1.5 mg l⁻¹) plus ascorbic acid at (120 mg l⁻¹) e. Callogenesis from leaf explants on MS + 2,4-D (1.0 mg l⁻¹) and ascorbic acid (160 mg l⁻¹) f. Leaf callus induction and shoot bud formation on MS + TDZ (3.0 mg l⁻¹) and NAA (0.5 mg l⁻¹)
2.4	<ul style="list-style-type: none"> a. Subculture of leaf callus from 2,4-D (1.5 mg l⁻¹) on MS + BAP (0.5 mg l⁻¹) and 2,4-D (1.5 mg l⁻¹) with ascorbic acid (120 mg l⁻¹) for increasing (proliferating) nodular callus b. Subculture of leaf callus from 2,4-D (1.5 mg l⁻¹) on MS + BAP (0.5 mg l⁻¹) and 2,4-D (1.5 mg l⁻¹) with ascorbic acid (40 mg l⁻¹) for shoot differentiation. c. Subculture of leaf callus on MS medium containing BAP (1.0 mg l⁻¹) and GA₃ (3.0 mg l⁻¹) with IAA (0.5 mg l⁻¹) produced embryogenic callus with shoot buds and roots. d. Subculture of leaf callus on MS medium containing BAP (3.0 mg l⁻¹) and NAA (0.5mg l⁻¹) induced greenish callus with shoot bud formation e. Subculture of leaf embryogenic callus with shoot bud on MS medium supplemented with GA₃ (1.0 mg l⁻¹) + IAA (1.0 mg l⁻¹) + ascorbic acid(40 mg l⁻¹) producing elongated shoots f. Subculture of leaf callus from MS+TDZ (3.0 mg l⁻¹) and NAA (0.5 mg l⁻¹) on same medium to proliferate callus and to produce shoot buds
2.5	<ul style="list-style-type: none"> a. Subculture of callus derived on MS + 2,4-D (1.5 mg l⁻¹) gave luxuriant callus b. Indirect embryo from callus explants

	<ul style="list-style-type: none"> c. Leaf embryogenic callus on MS + BAP (3.0 mg^l⁻¹) and NAA (0.5 mg^l⁻¹) d. Leaf embryogenic callus from MS + BAP (3.0 mg^l⁻¹) and NAA (0.5 mg^l⁻¹) on subculture to same medium proliferated the embryogenic callus and induced shoot buds. e. Somatic embryos formed on BAP (1.0 mg^l⁻¹) + GA₃ (2.0 mg^l⁻¹)
2.6	<ul style="list-style-type: none"> a. Embryo induction from leaf explants on BAP (1.0 mg^l⁻¹) + GA₃ (2.0 mg^l⁻¹) subcultured to MS + BAP (1.0 mg^l⁻¹) + GA₃ (3.0 mg^l⁻¹) produced embryogenic calli with elongated shoots. b. Leaf derived calli on MS + TDZ (3.0 mg^l⁻¹) with NAA (0.5 mg^l⁻¹) produced embryogenic callus. c. Green embryogenic callus production from brown callus d. Leaf derived calli on MS + TDZ (3.0 mg^l⁻¹) with NAA (0.5 mg^l⁻¹) subcultured on same medium produced embryogenic callus and shoot differentiation e. The induced leaf callus on MS + 2,4-D (1.5 mg^l⁻¹) and BAP (0.5 mg^l⁻¹) with ascorbic acid (120 mg^l⁻¹) f. Leaf callus on MS + 2,4-D (1.5 mg^l⁻¹) and BAP (0.5 mg^l⁻¹) with ascorbic acid (120 mg^l⁻¹) on subculture to MS + BAP (1.0 mg^l⁻¹) and GA₃ (3.0 mg^l⁻¹) produced embryogenic callus with shoots
2.7	<ul style="list-style-type: none"> a. Multiple shoots and elongated shoots b. Embryogenic callus with elongation of shoots. c. Acclimatized plantlet developed. d. Potted plantlets
2.8	<ul style="list-style-type: none"> a. Active centers in the callus which are involved in the proliferation of callus b. High percentage of vascularized cells compared to the normal callus cells c. An embryoid alongwith shoot bud d. Hard nodular callus e. Globular embryoid developed peripherally from the callus f. Cordate and club shaped embryoids
2.9	<ul style="list-style-type: none"> a. Meristematic regions of the callus in the peripheral region b. Development of an embryoid from old callus c. Development of an embryoid on a leaf primordium d. Bipolar embryo e. Shoot bud developed peripherally
2.10	<ul style="list-style-type: none"> a. A conspicuous apical cell in the shoot bud with a pair of primordial leaves (40x) b. A conspicuous apical cell in the shoot bud with a pair of juvenile leaves (10x) c. Apical shoot bud with tunica layer below which an apical cell is located

	<p>d. Initiation of embryoid or shoot bud from single cell</p> <p>e. 4-5 celled filamentous embryoid</p> <p>f. Cordate – shaped embryoid with suspensor</p>
2.11	<p>a. Embryogenic callus having shoot bud initiation</p> <p>b. Organization of xylem element before organogenesis of a morphological structure</p> <p>c. Higher percentage of cells got cytodifferentiated</p>
2.12	<p>a) Luxuriant nodular callus from internode on MS + 2,4-D (0.5 mg^l⁻¹)</p> <p>b) Callus initiation from stem explants on MS + BAP (3.0 mg^l⁻¹)</p> <p>c) The whitish, soft and compact callus induction of stem explants on MS + NAA (1.5 mg^l⁻¹)</p> <p>d) Luxuriant callus of stem explants on MS + BAP (3.0 mg^l⁻¹) and NAA (1.0 mg^l⁻¹)</p> <p>e) Multiple shoots on MS + BAP (1.0 mg^l⁻¹) and GA₃ (3.0 mg^l⁻¹)</p>
2.13	<p>a) Luxuriant green nodular callus on MS + BAP (1.0 mg^l⁻¹) + 2,4-D (0.5 mg^l⁻¹) and AA (120 mg^l⁻¹)</p> <p>b) Embryogenic differentiation into shoot buds on MS + BAP (1.0 mg^l⁻¹) and 2,4-D (0.5 mg^l⁻¹) and AA (40 mg^l⁻¹)</p> <p>c) Nodular, hard embryogenic callus induction on MS + TDZ (3.0mg^l⁻¹) and NAA (0.5 mg^l⁻¹)</p> <p>d) Luxuriant callus from stem inoculum on MS + 2,4-D (1.0mg^l⁻¹) + AA (160 mg^l⁻¹).</p> <p>e) The soft compact callus from internodal explants on MS + 2,4-D (1.5 mg^l⁻¹) subcultured on MS + 2,4-D (1.5 mg^l⁻¹) and BAP (0.5 mg^l⁻¹) with AA (120 mg^l⁻¹).</p> <p>f) Internodal callus from MS + BAP (0.5 mg^l⁻¹) and NAA (1.0 mg^l⁻¹) subcultured to MS + BAP (3.0 mg^l⁻¹) and NAA (0.5 mg^l⁻¹) produced embryogenic calli with shoot buds</p>
2.14	<p>a) Internode calli on MS + 2,4-D (1.0 mg^l⁻¹) and ascorbic acid (160 mg^l⁻¹) on subculture to 2,4-D (1.5 mg^l⁻¹) increased the callus proliferation.</p> <p>b) Differentiated plantlets on MS + GA₃ (1.0) + IAA (1.0 mg^l⁻¹) plus ascorbic acid (40 mg^l⁻¹) produced elongated shoots and roots.</p> <p>c) Callus induced on MS +TDZ (2.0 mg^l⁻¹) +NAA(0.5mg^l⁻¹) on subcultured to MS + BAP (1.0 mg^l⁻¹) + GA₃ (3.0mg^l⁻¹) produced embryogenic callus and multiple shoot formation.</p> <p>d) Internodal calli on MS + 2,4-D (0.5 mg^l⁻¹) + BAP + ascorbic acid subcultured to MS + BAP (1.0 mg^l⁻¹) and GA₃ (3.0 mg^l⁻¹) plus IAA (0.5 mg^l⁻¹) induced embryogenic calli with elongation shoots.</p> <p>e) Potted plantlets</p>
2.15	<p>a) Soft callus, loosely arranged cells some without nuclei –enuclated cells</p>

	<ul style="list-style-type: none"> b) Root induction c) Globular shaped embryoid d) Cordate shaped embryoid e) Club shaped embryoid f) Vascular elements got differentiated
2.16	<ul style="list-style-type: none"> a) Embryoid within the callus with 2-3 stalk cells, densely cytoplasmic with a conspicuous nuclei b) Embryoid with suspensor c) Meristemic zone with densely cytoplasmic cells peripherally d) Initiation of an embryoid or a shoot bud from the single cell which have devided once to form 2 nuclei e) Apical bud differentiating from the callus f) Cytodifferentiation cells below the organisation of a shoot bud
2.17	<ul style="list-style-type: none"> a) Vascularized cells b) Vascularized cells with annular and spiral thickenings c) 4 multiple shoot buds from the callus d) Shoot bud with 2 pair of primordial leaves e) Shoot bud with a pair of primordial leaves
2.18	<ul style="list-style-type: none"> a) Apical shoot bud with tunica layer below which an apical cell is produced b) Differentiation of vessel element from old callus c) Xylem cells are in contact & superimposed to form a connective link
2.19	<ul style="list-style-type: none"> a) The embryogenic callus and shoot production from stem explants with node on MS + BAP (3.0 mg^l⁻¹) b) Embryogenic and elongated shoot production from stem explants with node on MS + GA₃ (4.0 mg^l⁻¹) c) Multiple shoots and roots produced from stem explants with node on MS + GA₃ (1.0 mg^l⁻¹) and IAA (0.5 mg^l⁻¹) d) Microshoots and roots (with elongated shoot) shown on Ms + GA₃ (0.5 mg^l⁻¹) and IAA (1.0 mg^l⁻¹) e) Embryogenic callus from nodal explants of MS + Kn (1.5 mg^l⁻¹) subcultured on MS + Kn (1.0 mg^l⁻¹) and BAP (1.0 mg^l⁻¹) shown embryogenic callus proliferated f) Embryogenic callus from nodal explants on MS + BAP (3.0 mg^l⁻¹) on subcultured to BAP (1.0 mg^l⁻¹) and GA₃ (1.5 mg^l⁻¹) resulted in embryogenic proliferation of callus with multiple shoot
2.20	<ul style="list-style-type: none"> a) Embryogenic cytodifferentiation into shoot bud b) Embryogenic callus from MS + TDZ (0.5 mg^l⁻¹) on sub culture to MS + TDZ (4.0 mg^l⁻¹) increased embryogenic callus proliferation c) Embryogenic callus on MS + BAP (0.5mg^l⁻¹) with Kn (2.0 mg^l⁻¹) on subcultured to MS + GA₃(2.0 mg^l⁻¹) and IAA(0.5 mg^l⁻¹) resulted

	<p>to elongated shoots</p> <p>d) Nodal embryogenic callus induced on MS + GA₃ (1.5 mg l⁻¹) produced elongated shoots with roots, subcultured on MS + GA₃(1.5 mg l⁻¹) and IAA(1.0 mg l⁻¹)</p> <p>e) Differentiated plantlets for acclimatization</p> <p>f) Potted plantlets</p>
2.21	<p>a) The primary callus on MS +BAP (0.5 mg l⁻¹) and 2,4-D (1.0 mg l⁻¹) with ascorbic acid (80 mg l⁻¹) on subcultured to MS + BAP (1.0 mg l⁻¹) and GA₃ (3.0 mg l⁻¹) with IAA (0.5 mg l⁻¹) showed differentiation of multiple shoots and produced roots.</p> <p>b,c) Direct roots on MS +IAA of microshoots.</p>
3.1	<p>a) Callus induction from leaf explants on MS+BAP(0.5 mg l⁻¹) +GA₃(3.0 mg l⁻¹) transferred to liquid medium for suspension culture.</p> <p>b) Callus induction from stem explants on MS+BAP(0.5 mg l⁻¹) +NAA (3.0 mg l⁻¹) transferred to liquid medium for suspension culture.</p>
3.2	<p>a) Xylem elements</p> <p>b) Dumb-bell shaped cells</p> <p>c) Filamentous cells</p> <p>d) Mass aggregates</p> <p>e) Embryogenic cells</p> <p>f) Two- celled proembryo</p> <p>g) Filamentous embryo</p> <p>h) Embryogenic mass of cells</p>
3.3	<p>a. Embryogenic mass of cells.</p> <p>b. 2 embryogenic cells divided and became 4 embryogenic cells.</p> <p>c. Clusters of fused and individual embryos at various stages</p> <p>d. Embryogenic cell aggregates interspersed with xylem elements.</p> <p>e,f. Number of embryogenic cells with different shapes and number of xylem elements somewith nuclei.</p> <p>g. Different shapes of xylem elements.</p> <p>h. A embryogenic cell with 3-nuclei and the other an enucleated</p>
3.4	<p>a) Cell with 2 nuclei having single nucleolus</p> <p>b) Binucleate cell with 2 nucleolus</p> <p>c) Una cordate-shaped single cell with a single celled stalk</p> <p>d) One-celled with a suspensor</p> <p>e) Cordate shape of embryo with suspensor</p> <p>f) Dumb bell shaped of embryogenic cell</p> <p>g) g.Embryogenic mass of cells</p>
3.5	<p>a) Clump formation of nucleoli</p> <p>b) Torpedo shaped embryoids-with basal cells</p>

	<ul style="list-style-type: none"> c) Club shaped nucleus persisted in a tracheid d) Irregular shape of xylem element e) One of the xylem elements is with a distinct nucleus
3.6	<ul style="list-style-type: none"> a Bipolar embryo b,c,d,e. cells showing Papillate projections f. A cell to cell connection, sometimes, exchange of chromatin material between the two cells. g. Protoplasm shirk age h. The nucleous flow into the neighbouring cell and the cell becomes enucleated
3.7	<ul style="list-style-type: none"> a. Enlarged cell with a single nucleus and a nucleolus b. Embryogenic mass peripherally with embryoids c. Various shapes of nuclei in suspension cells d. Nucleus is disintegrating while xylem differentiates e,f,g. Differentiated xylem elements h Vascularization
3.8	<ul style="list-style-type: none"> a. Initiation of organogenesis in embryogenic mass b. Pro-embryogenic cells c. Differentiation of vascularized cells with various thickenings d. Distinct cells with a detectable cytoplasm and nucleus e. globular embryo with dense cytoplasm f. a-4-celled embryo g, h. Embryos of various stages on MS solid medium for further growth
3.9	<ul style="list-style-type: none"> a. Synthetic seed b. Germination of synthetic seed on MS medium c,d. Multiple shoots from single synthetic seed on MS medium containing BAP (1.0 mg l⁻¹) and GA3 (1.0 mg l⁻¹) e. Elongation of shoots on the same medium composition plantlet after germination from the synthetic seed f. Hardened potted plants.
4.1	<ul style="list-style-type: none"> a. Leaf callus cells showing abnormal behaviour (100X) b. Cytodifferentiation of a daughter cells before separation (100X) c. Cells showing varied number of nuclei (40X) d. A callus cell showing 6 nuclei (100X) e. A callus cell with 12 nuclei (40 X) f. A callus cell with 15 nuclei (40 X)
4.2	<ul style="list-style-type: none"> a. Multinucleate cell derived from the stem (40X) b. Multinucleated cells, all the nuclei are in synchronous division (100X) c. Synchronous division in 4 nuclei (all nuclei) (40X) d. Synchronous division in most of the multinucleated cells (40X) e. Asynchronous division of nuclei in the cells showing one in

	<p>anaphase stage with bridge and the other in interphase stage</p> <p>f. Asynchronous division of nuclei in the cell showing one in metaphase stage and other in prophase stage (40X)</p> <p>g. Asynchronous division of nuclei in the cell showing one in anaphase stage and the remaining 4 in in interphase stage (40X)</p> <p>h. Asynchronous division of nuclei in the cell wherein one in rest, the other at metaphase (100X)</p>
4.3	<p>a. Leaf callus cells showing</p> <p>b. A nucleus with 2 nucleoli (100X)</p> <p>c. Nuclei having 3 and 4 nucleoli (100X)</p> <p>d. A nucleus showing 5 nucleoli (100X)</p> <p>e. A nucleus showing 7 nucleoli (100X)</p> <p>f. 12 nucleoli within a single nucleus (100X)</p> <p>g. Uninucleated condition (40X)</p> <p>h. Enucleolated cells from 1 year old callus (100X)</p>
4.4	<p>a. Papillate projection from the cell wall (100X)</p> <p>b. Migration of the nucleus along with the cytoplasm (100X)</p> <p>c. The nucleus flows into the neighbouring cell and cell becomes empty (100X)</p> <p>d. Binucleated cells show internuclear connections and possibly exchange of chromatin material (100X)</p> <p>e. Knob-like structure on the nuclear membrane (40X)</p> <p>f. Persistence of nucleolus in an endoreduplicated cell (100X)</p> <p>g. Amitosis of a micronucleus in a dumbbell shape (40X)</p> <p>h. Amitotic division</p>
4.5	<p>Mitotic aberrations :</p> <p>a. Anaphase stage with 1 bridge (100X)</p> <p>b. Anaphase stage with more bridges (100X)</p> <p>c. Anaphase stage with 1 laggard (100X)</p> <p>d. Anaphase stage with 2 laggards (100X)</p> <p>e. Anaphase stage with bridges and laggard chromosomes (100X)</p> <p>f. Prominent nucleolus in each set of chromosomes (100X)</p> <p>g. Anaphase stage with “V” shape of laggard (40X)</p>
4.6	<p>a. Anaphase in a polyploidy cell (40X)</p> <p>b. Anaphase bridge with a gap between in the bridge (100X)</p> <p>c. Anaphase with spindle fibres (100X)</p> <p>d. Alignment of chromosomes peripherally inside the in nucleus of callus cells (40X)</p> <p>e. Few chromosomes at metaphase stage (100X)</p> <p>f. Few chromosomes at metaphase stage with spiral fibre (100X)</p> <p>g. Chromosomes around the nucleolus in cell (100X)</p>
4.7	<p>Mixoploid callus showing</p> <p>a. A diploid cell (100X)</p> <p>b. A diploid cell (100X)</p> <p>c. A tetraploid cell (100X)</p>

	<ul style="list-style-type: none"> d. A hexaploid cell (100X) e. A hexaploid cell (100X) f. A octaploid cell (100X) g. A polyploid cell (100X)
4.8	<p>Chromosomal aberrations showing</p> <ul style="list-style-type: none"> a. Anaphase having 2-6 bridge chromosome bridges (100X) b. Anaphase having 2-7 laggard chromosomes (40 X) c. nuclear connections at late anaphase (40X) d. A distinct nucleolus in a cytodifferentiated cell (40X) e. Transformation of callus cells into tracheids (100X) f. Callus cells exhibited cell division preceded by xylogenesis (100X) g. Cytoplasmic channels (100X)
4.9	<p>Different stages of mitosis division in callus cell of <i>A. vulgaris</i> L. on MS+2,4-D</p> <ul style="list-style-type: none"> a. Prophase stage (100 X) b. Late prophase stage (100 X) c. Prometaphase stage (100 X) d. Metaphase stage (100 X) e. Late metaphase stage (100 X) f. Early anaphase stage (100 X) g. Anaphase stage (100 X) h. Telophase stage (100 X)
4.10	<p>Somatic chromosomal abnormalities in callus cells of <i>A. vulgaris</i> L. on MS+2,4-D in anaphase stage with</p> <ul style="list-style-type: none"> a. Scattered chromosomes (100 X) b. Scattered chromosome (100 X) c. Laggard chromosome (100 X) d. Laggard chromosome and bridge chromosomes (100 X) e. Bridge chromosome (100 X) f. Sticky chromosome (100 X)
4.11	<p>Different stages of mitosis division in callus cell of <i>A. vulgaris</i> L. on MS+BAP</p> <ul style="list-style-type: none"> a. Prophase stage (100 X) b. Prometaphase stage (100 X) c. Metaphase stage (40 X) d. Anaphase stage (100 X) e. Early telophase stage (40 X) f. Telophase stage (40 X)
4.12	<p>Somatic chromosomal abnormalities in callus cells of <i>A. vulgaris</i> L. on MS+BAP in anaphase stage with</p> <ul style="list-style-type: none"> a. Scattered chromosomes (100 X) b. Laggard chromosomes (100 X) c. Bridge chromosomes (100 X) d. Bridge chromosomes with gap between bridge (40 X) e. Bridge chromosome and laggard chromosome (100 X)

	<ul style="list-style-type: none"> f. Sticky chromosome (100 X) g. Micronuclei (100 X)
4.13	<p>Different stages of mitosis division in callus cell of <i>A. vulgaris</i> L. on MS+BAP+GA3</p> <ul style="list-style-type: none"> a. Prophase stage (40 X) b. Prometaphase stage (100 X) c. Metaphase stage (40 X) d. Anaphase stage (100 X) e. Late anaphase stage (100 X) f. Telophase stage (40 X)
4.14	<p>Somatic chromosomal abnormalities in callus cells of <i>A. vulgaris</i> L. on MS+BAP+GA3 in anaphase stage with</p> <ul style="list-style-type: none"> a. Scattered chromosomes (100 X) b. Laggard chromosomes (40 X) c. Strong and thick bridge chromosome and laggard d. chromosomes (100 X) e. Bridge chromosomes (100 X) f. Sticky chromosomes (40 X) g. Micronuclei (100 X)