COTTON Innovate

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Scientific Talk

Under the aegis of the innovative club, a talk on "WNT signaling" was given by Mr. Joy Das, Scientist, Biotechnology on March13, 2015. Melanin, a light-absorbing biopolymer produced as a result of melanogenesis in melanocytes, is the major pigment present in the surface structures of mammals and is widely distributed in plants too. This pigment plays a photoprotective role to shield the skin from adverse affects of UV light and also determines the color of skin, hair, and eyes in human. Biosynthesis pathway of melanin involves critical enzymes like tyrosinase, tyrosinase like protein-1, dopachrome tautomerase/tyrosinase like protein-2 (TRP-2) etc. Another key protein known as Wnt, has been found to be associated with melanogenesis and hair follicle development by regulating the activity of TRP and associated proteins. Wnt protein has been also reported to orchestrate a myriad of developmental processes in metazoa viz. embryo development, cell fate determination, cell polarity and proliferation etc. Although a few homologs of proteins, which act as negative regulator of Wnt signaling has been identified in plants, a robust evidence of existence of Wnt signaling pathway in plants is yet to be unveiled. However, very recent report indicating the presence of Wnt3a protein (GenBank: KHF99765.1) and some other players of Wnt signaling in *Gossypium arboreum*, has irrefutably marked the gateway of a new regime to explore a novel signaling pathway in the kingdom plantae.

Literature Scan

How Plant Cells Orient during Cytokinesis

INTRODUCTION

Plants are organisms composed of non-motile cells which are protected by rigid cell walls. Positioning of the cells in the plant is governed by a continuation of cell elongation and cell division with no cell migration. Thus, cells adjust with the neighboring cells. The proper orientation of the new cells during cell division results in robust plant form and structure. Plant cells divide by building a new cell wall between the daughter cells.

THEORY & PRINCIPLES

The mechanism involves the establishment of division plane in the cell cortex prior to mitosis. The new cell wall gets inserted at this site upon completion of cytokinesis. Cyto-skeletal structure is formed unique to plant cells when the division plane is initiated. This structure is known as the pre-prophase band (PPB), appearing during G-2 (cell cycle phase) and disappearing before metaphase. The PPB is a cortical band of parallel microtubules (MTs) and microfilaments (MFs) that encircle the cells at the future division plane. The breakdown of PPB with the formation of mitotic spindle results in the segregation of chromosomes to daughter nuclei. The spindle formation is perpendicular to the plane delineated by the PPB. Phragmoplast, a plant specific cytokinetic apparatus, formed between the daughter nuclei, containing both MTs and MFs, acts as scaffolding for the building of a new cell wall (cell plate). The spatial control of cytokinesis involves the formation of PPB, spindle and phragmoplast and also the forces that influence their positioning. Imaging of GFP fusion proteins in the living cells have revealed new and informative observation of spatial control of plant cell division.

In large vacuolated cells, formation of PPB coincides with a global reorganization of the cytoplasm to form the phragmosome, a plate like arrangement of transvascular cytoplasmic strands. The strands connect a cortex / plasma membrane to the nucleus. Disruption of PPB leads to aberrant orientation of the cell division. Besides, the pre-prophase nucleus, cell geometry, cell polarity and all the extrinsic signals appear to play a role. The migration and the centering of the nucleus by a MT based mechanism appears to be an important part of the division plane selection process in cells ; nuclear position alone cannot decide the division plane. Cell division in elongated cell is either transverse or longitudinal. Other factors prevail viz. cell polarity, cell geometry which contribute to the division plane selection. Asymmetric cell division plays a major role in division plane selection in cell polarity. However, symmetric cell division planes are governed by polarizing cues as well. In cell geometry, firstly, cell plates do not attach to the mother cell wall or the same point as a mature neighboring cell wall. Secondly, the plane of cell division, is often aligned with the shortest axis of the cell, although many exceptions to this rule exist. The cell geometry arouse itself to follow these division plane rules. This is accomplished by the cytoplasmic strands, mostly Microtubules and Microfilaments which are under tension in the pre-prophase. This results in the adoption of shortest path by the mobile elements, resulting in the alignment of the division plane with the cells shortest axis. As a new cell ages and strengthens, it creates an invert protruding vertex in its own cell file and corresponding outward protruding vertex in the neighbouring files. Hofmeister rule states the new cell walls are typically formed perpendicular to the mother cell axis of elongation.

MOLECULAR INFLUENCE OF CELL DIVISION PLANE

Some of the proteins viz. KCA-1, kinesin protein determine the initial orientation of the spindle. Other genes viz. tangled 1 (tan 1), causing high frequency of misoriented cell divisions (Smith *et al;* 1996) ; At TAN of TAN 1 homologue governs the spatial control of cytokinesis, the mutations of which result in misoriented divisions due to misguided phragmoplast.

Two more genes viz. PHRAGMOPLAST ORIENTING, KINESIN 1 & 2 (POK 1 & POK 2) ; identified as interacting genes with TAN 1 gene in maize confer dwarf double mutants with misoriented plane of cell division. This indicates the role of kinesins in the orientation of the cell division. It has been further revealed that actin bundles are involved in phragmoplast guidance, connect the edge of phragmoplast to the cortex in fixed cells by fluorescent phalloidin injected cells resulting in cells expressing fluorescent binding proteins. It has also been observed that myosin, an actin based motorprotein is involved in lateral expansion of the phramoplast and also in phramoplast guidance. Thus, myosins are required for division plane establishment and / or maintenance. Phragmoplast MTs play an important role in cell plane formation.

Thus, the synchrony of different cell organelles and the genes and proteins involved therein in the cellular processes emphasize the importance of cell orientation and cell plane division.

REFERENCES & FURTHER READINGS

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Image Source : *Plant Cell Monographs* (9) Cell division control in plants' (eds. D.P.S.Verma and Z. Hong). Springer Verlag, Berlin, Heidelberg. pp. 35

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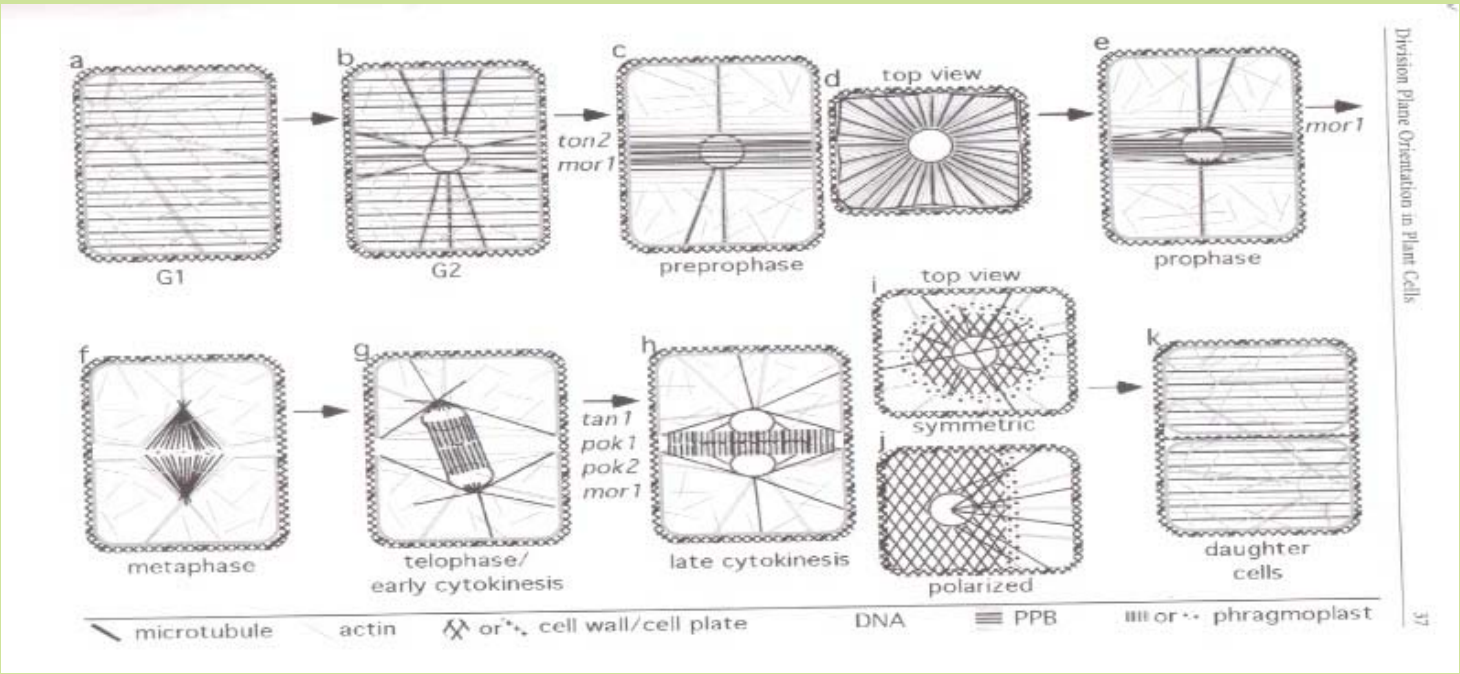

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