DIFFERENTIATION OF EPIDERMIS WITH SPECIAL REFERENCE TO STOMATA

MBOTCC-6 (UNIT-IV) M. Sc. Sem-II (2018-20)

Introduction:

Epidermis of all plant organs is the outermost multifunctional cover or skin which represents the point of contact between the plant and the external environment. As such, it also exhibits diversity in structure. It is primarily a protective layer which protects the underlying tissues against excessive loss of water by transpiration and mechanical injury. Subsidiary functions like storage of water, mucilage secretion and, though rarely, even photosynthesis, may also be carried out. But for stomatal and lenticular openings, epidermis is a continuous layer which derives its origin from the protoderm meristem.

Multifunctionality of the epidermis may be ascribed to the different kinds of specialized cells which differentiate from the early primordial epidermis in adaptively significant patterns and frequencies. There are evidences to suggest that even the less specialized cell types may require certain signals to ensure their correct differentiation and patterning. Works on stomatal development have focused on a cell lineage mechanism.

Stomatal Complex (Stomatal Apparatus)

(i) A stomatal complex consists of two specialized epidermal cells which are usually kidney-shaped (or even of other shapes) and are placed closely appressed together and have differential wall thickenings. They are called guard cells as they guard the stomatal pore.

(ii) Other surrounding epidermal cells are called subsidiary cells or accessory cells.

(iii) Inner walls of the guard cells bordering the stomatal pore (stoma) are thick and inelastic while rest portions of their walls are

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thin and elastic.

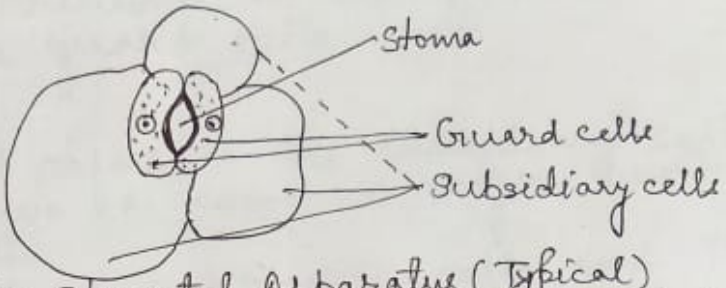

Fig: Stomatal Apparatus (Typical)

(iv) Guard cells have dense cytoplasm, prominent nuclei, chloroplasts, and even starch grains.

(v) A cavity is present just beneath the stoma what is called sub-stomatal chamber or cavity. It is in communication with the intercellular space system of the internal tissues.

(vi) Uneven thickening of the walls of the guard cells and their turgidity - flaccidity rhythms govern stomatal opening and closing through variously interpreted mechanisms.

ONTOGENY OF STOMATAL COMPLEX

Stomatal Meristemoid:

(i) It refers to a protoderm cell whose first or successive divisions lead to the formation of guard cells of a stoma.

(ii) Marginal meristems produce marginal initials that in turn give rise to the adaxial and abaxial leaf epidermal layers.

(iii) Marginal initials undergo anticlinal divisions and subdivisions.

(iv) The derivative cells form protoderm cells. Some specialized prodermal cells transform into stomatal meristemoid.

Meristemoid:

(i) It refers to the cells that are derived from the stomatal meristemoid.

(ii) They retain the capacity for further divisions.

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Guard cell initial (Guard cell mother cell):

This refers to a meristemoid whose bisection results in the formation of two sister guard cells.

Mesogene:

(i) It refers to the subsidiary cells which have a common origin with guard cells

(ii) Thus subsidiary cells and the two sister guard cells are derivatives of the same meristemoid.

Perigene:

(i) It refers to the subsidiary cells that have a different origin from guard cells.

(ii) The cells which form subsidiary cells occur around the meristemoid that forms guard cells.

Divisions in the stomatal meristemoid

(i) Stomatal meristemoid, by several divisions, forms a stoma.

(ii) The meristemoid is usually isodiametric or polygonal in shape and possesses a single conspicuous nucleus with denser cytoplasm.

(iii) Usually the stomatal meristemoids are initiated between the mature stomata (e.g., gymnosperms and angiosperms).

(iv) Sometimes their origin is acropetal (eg. stem of Psilotum); basipetal origin is observed in Convolvulaceae, Rubiaceae, etc. Simultaneous differentiation is observed in Erythrina (Leguminosae)

(v) The differentiation in a stomatal meristemoid and its subsequent divisions leading to the formation of a stoma vary in different groups of plants.

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Ontogeny of Stoma in *Allium cepa*: A typical example

(i) Stoma in *Allium cepa* consists of a pair of guard cells and a pore. Guard cells are crescent-shaped and devoid of any subsidiary cell.

(ii) Stoma develops from the stomatal meristemoid which is a transformed proto-dermal cell. It is elongated and contains dense cytoplasm with a conspicuous nucleus and vacuoles.

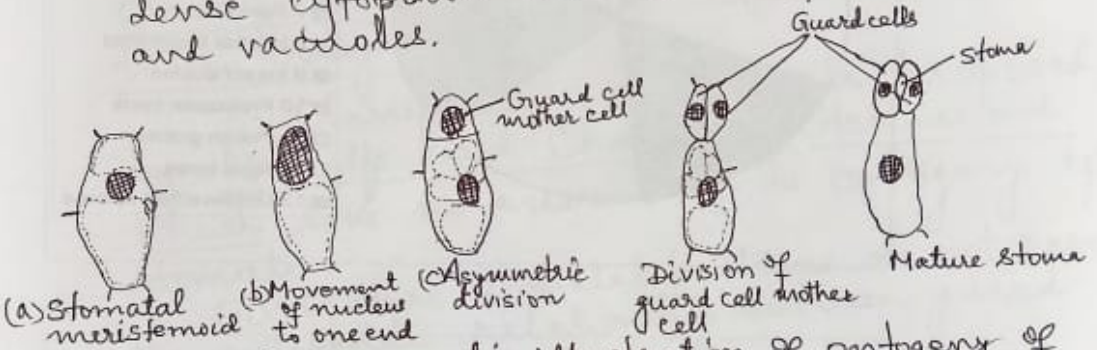

Fig. – Diagrammatic illustration of ontogeny of stomata in *Allium cepa*

(iii) Nucleus occupies the central position. Prior to division it gets shifted to one end of the stomatal meristemoid while the vacuoles occupy the opposite end. A differential cytoplasmic distribution occurs.

(iv) Stomatal meristemoid undergoes asymmetrical division resulting in a small cell at the distal end and a large one at the proximal end. The latter becomes less specialized.

(v) Guard cell mother cell contains proplastids, microbodies, dictyosomes, starch and all the usual organelles. A band of microtubules becomes evident around the nucleus.

(vi) Now the guard cell mother cell divides symmetrically by a wall parallel to the long axis of the leaf to produce two daughter guard cells.

(vii) The two daughter guard cells separate to form a median pore (stoma). Pectinase is supposed to be involved in this process.

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(viii) Increased pressure within the guard cells is believed to cause their mechanical separation thus forming a median pore (stoma).

(ix) The two daughter guard cells gradually assume their characteristic crescent shape thus forming an elliptical stoma.

(x) Subsidiary cells in other species are believed to originate from the adjoining epidermal cells.

Classification of Stomatal types based on their ontogeny

(i) Classification of stomata proposed by Metcalfe and Chalk and by Stebbins and Khush take no account of the ontogeny of stomata

(ii) Mature stomatal patterns do not reveal the ontogenetic relationship between guard cells and subsidiary cells.

(iii) A new classification has been proposed by Pant based on the ontogenetic relationship of guard cells and subsidiary cells.

Mesogenous — Same meristemoid gives rise to guard cells and subsidiary cells. It has four sub-types: Tetralabrate, Trilabrate, Dolabrate (Mesoparacytic, Mesodiacytic, Pyrrosia type) & Unilabrate.

Perigenous — Subsidiary cells and guard cells do not have a common origin.

Mesoperigenous — One stomatal meristemoid gives rise to one mesogene subsidiary cell and gcmc. The rest subsidiary cells are perigenous.

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