For B.Sc. Part II (Sub.) Group B (Anatomy and Embryology)

ANATOMICAL ADAPTATIONS IN XEROPHYTES

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Lecture No.36

Xerophytes

- Plants adapted to survive under very poor availability of water.
- Plants like the cacti and other succulents are typically found in deserts where low rainfall is the normal phenomena, but few xerophytes can also be found in moist habitats such as tropical forests, exploiting niches where water supplies are limited or too intermittent for mesophytic plants
- Plants that live under arctic conditions may also have a need for xerophytic adaptations, as water is unavailable for uptake when the ground is frozen. Their leaves are covered with silvery hairs.
- Some plants lives in very dry situations while on the other hand some are living in conditions of fairly reasonable supply of water.

- The plants growing in dry situation develop a large and deeply penetrating root system capable of efficient absorption.
- Some plants grows in marshy places ,which possess higher osmotic concentration and due to this higher concentration within plants, the absorption of water from the marshy soil takes place (e.g. *Molinia*).

➢ Usually xerophytic plants possess succulent and small leaves having less surface exposed to wind gusts.

➢Some times leaves contain abundance of mucilage , which tends to reduce transpiration.

➢In addition of these morphological adaptations, the plants possess many anatomical xerophytic features.

Classification of Xerophytic plants on the basis of their morphology and life cycle pattern:

➢ On the basis of their morphology and life cycle pattern xerophytic plants are classified into following category

(i) Ephemeral Annuals: These plants are also called as drought evaders or drought escapers. They are annuals and complete their life cycle within a very short period. They do not withstand dry seasons but actually avoid them. *Argemone mexicana*.

(ii). Succulent:

These plants grow in habitats with less or no water. They store water whenever it is available. They have succulent and fleshy organs like stems, leaves and roots which serve as water storage organs and accumulate large amounts of water during the brief rainy seasons. *Euphorbia* and *Opuntia*.

(iii). Non-Succulent Perennials:

These are drought resistant and called as true xerophytes. They possess a number of morphological, anatomical and physiological characteristics which enable them to withstand critical dry conditions. *Calotropis*, *Acacia*, *Casuarina* and *Nerium.*

Anatomical adaptations in xerophytes

1. Anatomical adaptations in Xerophytic leaves.

✓ Epidermis is the organ that is most strikingly modified in xerophytes leaf.

✓ Cells of epidermis are small but compactly arranged. It is single layered with thick walls.

✓ Occasionally epidermis is multilayered- may be on the dorsal surface (*Ficus)* or on both the surface *(Nerium)*

Stomata

✓ Stomata are of sunken type.

✓ Reduction of transpiration is of utmost importance and it is possible only if the stomata number per unit area is reduced or if the stomata are elaborately modified in their structure.

✓ Walls of guard cells and subsidiary cells are heavily cutinised and lignified.

✓ The stomatal cavities are often provided with stomatal hairs.

✓ In certain desert plants, such as *Capparis spinosa and Aristida ciliata stomata may* sometimes get blocked due to deposition of resinous matter or wax.

Mesophyll tissue

✓ Mesophyll tissue well developed and differentiated into compactly arranged palisade tissues and loosely arranged spongy tissue.

✓ Palisade parenchyma is usually present towards dorsal surface and are arranged in a single layer.

✓ In *Nerium, Ficus and Atriplex,* palisade is present on both adaxial and abaxial surfaces and spongy tissues lie in between the palisade layers.

✓ Vascular tissues are well developed and are differentiated into xylem with lignified elements and phloem.

✓ In addition to central vascular bundle in the midrib region, there are several other vascular bundles too as seen in *Nerium.*

✓Presence of cystolith (deposition of calcium carbonate) in certan cells of the upper epidermis

✓ Mechanical tissues are well developed, including several kinds of scelreids.

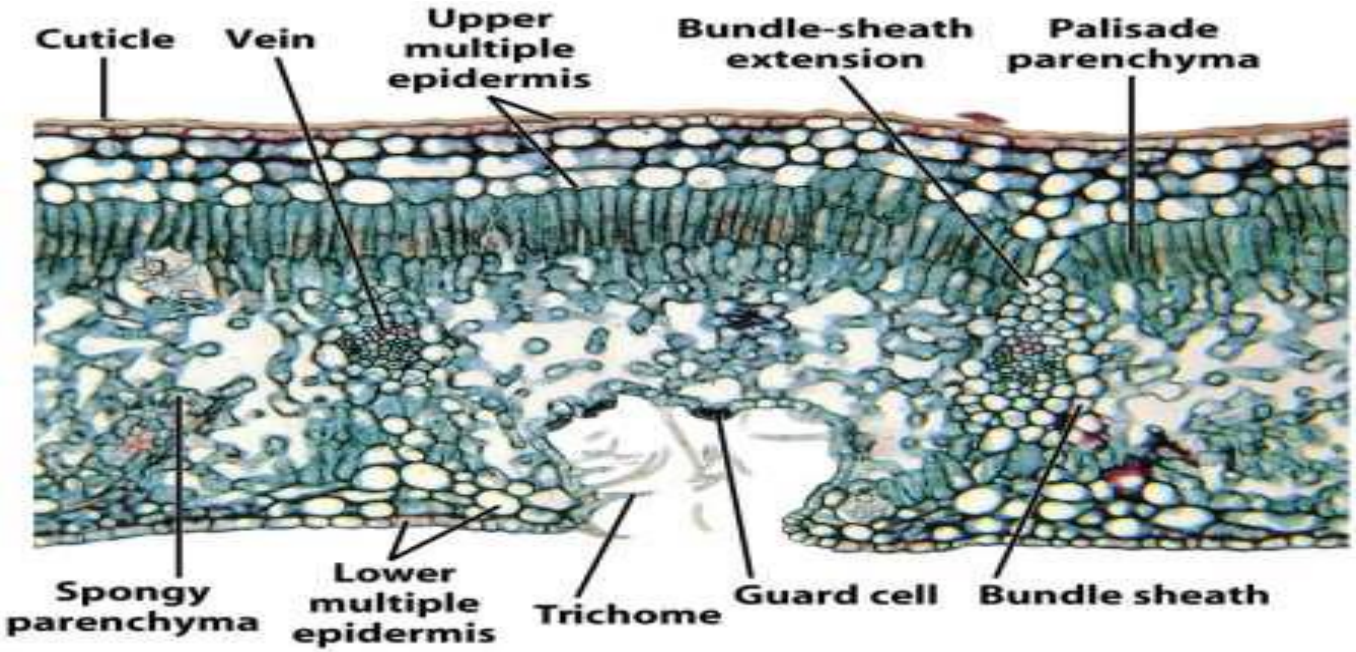

Figure: Palisade layer in both abaxial and adaxial surface of *Nerium leaf*

➢ In some non succulent xerophytes *(Ammophila, Agropyron)* leaves become rolled and folded in such a way that stomata occupy the hidden position, thus minimizing the rate of transpiration.

Bulliform cells

✓ Grass leaves have motar cells which play important role in rolling of the leaves during the period of dryness.

✓ These cells are thin walled, greatly enlarged and sensitive to turgor changes.

➢ When bulliform cells are turgid, leaf remains flattened and when flaccid, the lamina rolls and minimize the exposure of transpiring surface.

Modification of leaves

Phyllode

✓ Phyllode is the modification of leaf in which Petiole gets modified to form a flattened and leaf-like structure e.g. *Acacia auriculiformis*

Anatomical adaptations seen in Xerophytic stems

Epidermis

✓ Epidermis is well developed with thick walled cells.

✓ Thick cuticle gets deposited on the outer surface of the cells.

Deposition of cuticle is multilayered in *Capparis* stem. The thickness of deposition is directly proportional to the xeric conditions.

Epidermal hairs

✓ Multicellular epidermal hairs made up of rectangular cells, apical cell is rounded and slightly bulbous are present in *Bougainvillea* stem and in *Casuarina* stem it arises from base of furrow and each trichome is sickle shaped.

Hypodermis

✓Hypodermis is well developed and is made up of several layers of thick walled cells.

✓Hypodermis is composed of collenchyma cells or sclerenchyma cells.

✓ In *Casuarina*, T-shaped sclerenchymatous hypodermis is found below the ridges.

✓ Stomata are sunken, if present.

✓ Xylem and phloem are well developed.

✓In succulent xerophytes, the ground tissue of stem is made up of thin walled parenchymatous cells.

✓These cells preserve excess of water and mucilage in them and therefore the stem is fleshy.

Modification of stem

Phylloclade

✓ Stem becomes flattened, green leaf-like and performs photosynthesis.

✓Stem shows nodes and internodes. Sunken stomata present on both sides.

✓ Thick sclerenchymatous patches uniformly distributed above each vascular bundle.

✓ Well developed layers of palisade on both sides

Cladode

✓ Cladode is the modification of stem in which a branch of single internode is flattened and becomes leaf-like. The proper leaf is reduced to a scale in the axil of which develops a group of linear, narrow structure called cladode.

✓The epidermis is covered externally by a thick cuticle.

✓The palisade and spongy cells contain abundant chloroplasts.

✓ Stomata are few in number as a check against transpiration.

Adaptations	Function
Thick cuticle	Protection against desiccation
Trichomes	Maintains humid air around stomata
Sclerenchymatous hypodermis	Protects internal tissue from high light intensity.
Thin walled parenchyma	Preserve excess of water and mucilage
Phylloclade, Sunken stomata Sclerenchyma surrounds vascular bundle	Reduces transpiration
Cladode Well developed palisade cells	Increase in photosynthetic activity

Summary: xerophytic adaptations in stem

Adaptations seen in xerophytic roots

✓ Presence of suberised exodermis- regulates the inverse flux of water.

✓ Water storage parenchyma cells in cortical region.

✓ Presence of additional layers of cells with thickened walls around the stele and lignified pith in *Asparagus acutifolius.*

✓ Endodermis with thickened cell walls and additional layers of thick walled cells around stele in *Lygeum spp*

Adaptation	Function
Suberised exodermis	Regulates reverse flux of water.
Parenchyma in cortex	Stores water
Additional layer of thick walled cells around stele	Prevents desiccation
Thick walled endodermis	Regulates reverse flux of water

Summary: xerophytic adaptations in root

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Thank You!!!