MECHANICAL TISSUES IN PLANTS

Types, structure and function

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INTRODUCTION

- The tissues giving the mechanical support in the plant body are known as mechanical tissue. Not all the plants, but larger land plants and their organs have to bear different types of strains, and for that they require definite mechanical tissue.

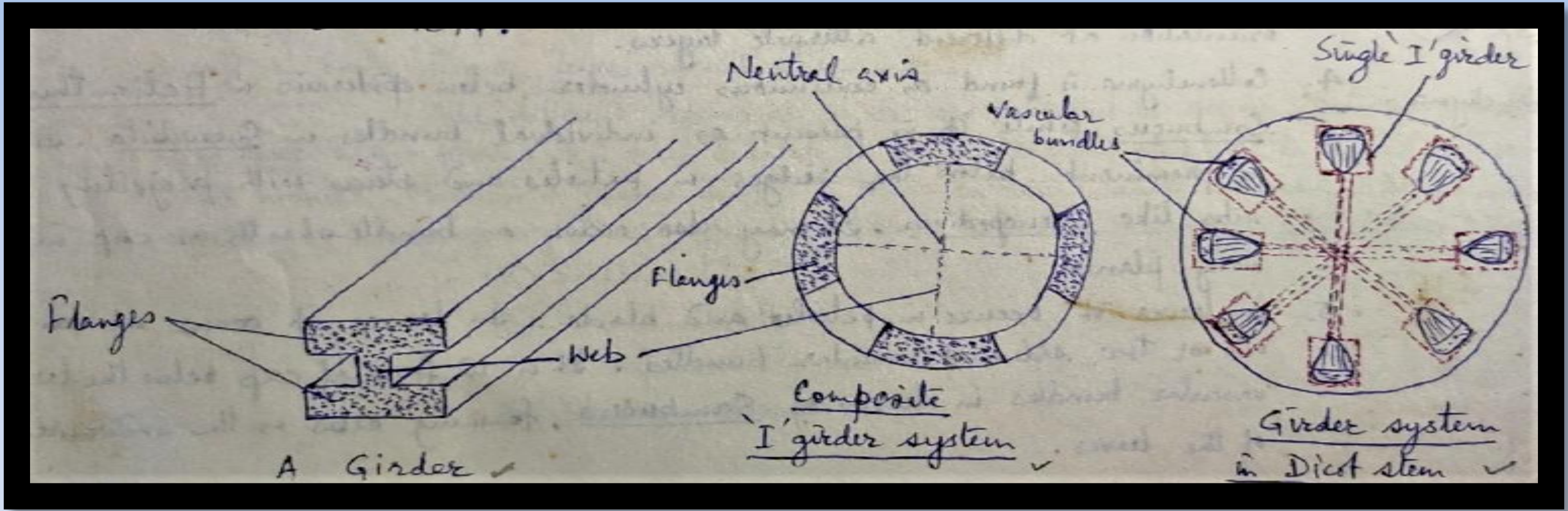
- The most important mechanical tissues are sclerenchyma fibres with highly lignified walls, sclereids with massive deposition of lignin and collenchyma with thick end walls.

PRINCIPLE OF DISTRIBUTION

- The distribution of these tissues are very interesting and highly technical. The principle of distribution is quite similar to those of engineering works.

- In the second half of nineteenth century, Schwendener (1874) made comprehensive study on the distribution of the mechanical tissues in plants. He treated sclerenchyma as an isolated system and disregarded the soft tissues in which they remain embedded.

Resemblance with ferro-concrete structure will be helpful in understanding that the thick walls are comparable to iron frame and soft tissues to the concrete.



The ‘girder system’ displayed in the above diagram has been devised by Haberlandt (1918) and named as ‘Stereome’.

TYPES OF MECHANICAL TISSUES

1. Simple turgid cells | 2. Thick cellulose wall | 3. Collenchyma | 4. Sclerenchyma

1. Simple turgid cells

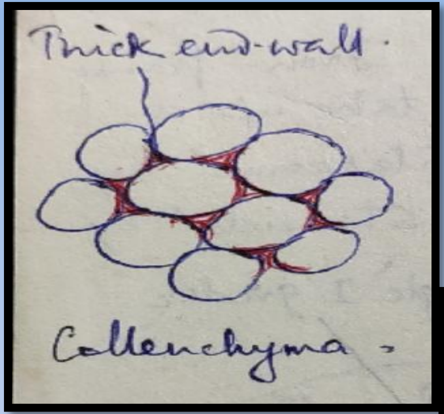
- In unicellular or colonial forms, turgidity of cells is sufficient to provide mechanical strength. There are unicellular, colonial, filamentous or thalloid forms in thallophyta, who maintain their body shape and strength.
- Many hydrophytic phanerogams have very less mechanical tissues and they get their tensile strength by cell turgidity. Succulent leaves like **Gasteria** also have turgid parenchyma.

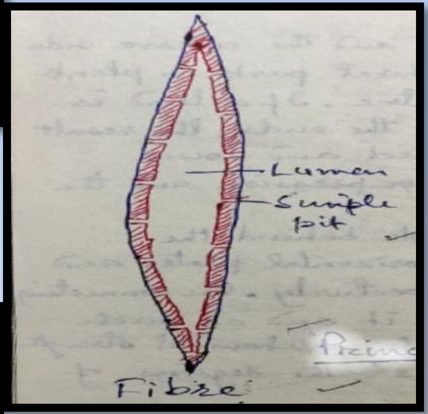
2. Thick cellulose wall

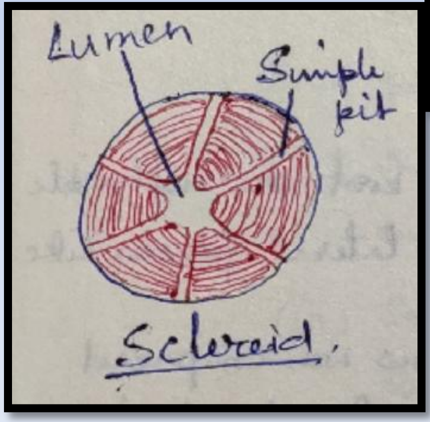
There are many examples, where the epidermal wall has thick layer of cellulose due to hemicellulose, pectin or cutin in most of the plants or the multilayered epidermis (***Nerium, Ficus***, ***Agave, Peperomea, Begonia*** etc.) is found.

3. Collenchyma

In collenchymas, thickening materials like pectin, hemicelluloses and protein are deposited at the corners of the epidermal cells. They impart elasticity along with strength. Elasticity is due to hydrated pectin on the wall. Collenchyma is found below epidermis in most of the dicot stems like ***Helianthus, Calotropis*** etc. While in ***Cucurbita, Chenopodium***, it is found like bundles. It is also found in petioles and leaves.







4. Sclerenchyma

Sclerenchyma is the toughest of all the tissues. It is the most prevalent mechanical tissue in plants, found in all the organs of the higher plants. Sclereids, fibres and tracheary elements are the examples. Within different organs, it may be found in hypodermis, cortex, pericycle, vascular bundle and pith. The development of secondary growth enhances the sclerenchymatous material in plants.

NATURAL STRESS AND TENSION FACED BY PLANTS

The distribution of mechanical tissues in different organs of plants are governed by natural adaptation to the needs of the plants. The basic principle of the distribution is to gain maximum strength with minimum use of mechanical tissues.

The different organs of plants are subjected to different strains and stress in their habit form. Mechanical tissues develop in plants to resist such strains and stress.

The different kinds of resistance offered by plants have been classified into following types.

A. Inflexibility

B. Inextensibility

C. Incompressibility

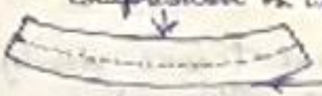
D. Shearing stresses

A. Inflexibility

- Aerial parts of plants are subjected to lateral bending stress. The distribution of mechanical cells in inflexible organs was compared with the ‘I’ girder system, which is used in the construction of railway tracks and bridges.
- Schwendener(1874) described such construction and the principle associated with. In ‘I’ girdle, the horizontal and vertical plate is termed as flanges and web respectively.

Web functions as neutral line having no strain on it. The region of greatest tension is two surfaces in the form of flanges. A single pair of flanges of a girder can resist lateral force from only one side. So, in plants, there are many girders joining laterally and making a whole circle of flanges. The middle of the webs intercepts each other forming a neutral central zone.

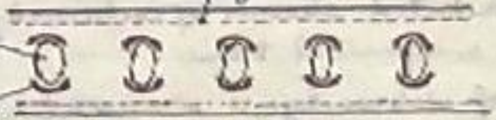
cells that are considered as flanges.



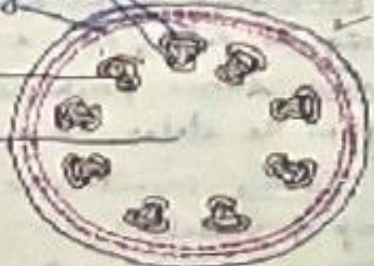
Flange in strain

Vascular bundle & sheath representing single 'I' girder

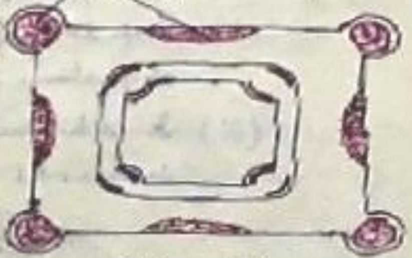
Single 'I' girder



Leaf in Cyperaceae showing sclerenchymatous patches



Stem of Cyperus showing sclerenchymatous layer & bundle sheath



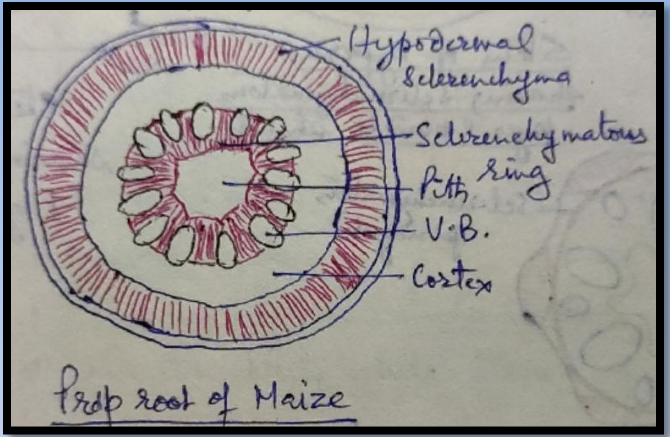
Stem of Leonurus showing angular 'I' girder system

Sunflower stem showing band of collenchyma

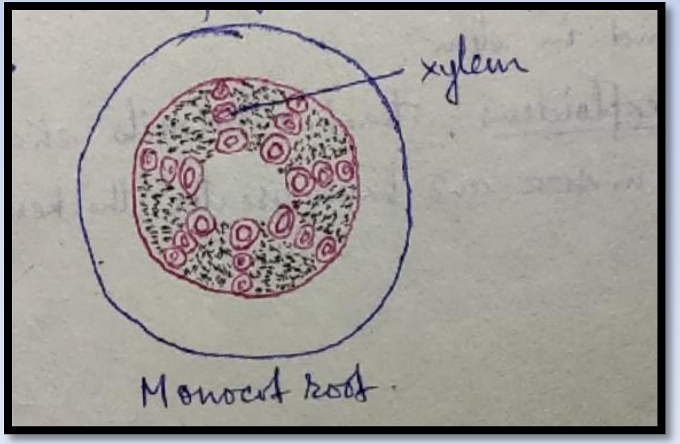
Cucurbita stem with collenchymatous patches.

B. Inextensibility

It is a type of stress where longitudinal pull or tension is affected under soil. So, roots, rhizomes, stolon, sucker face this tension. Many hydrophytes are stressed due to water current. Fruit stalks in heavy types also suffer.



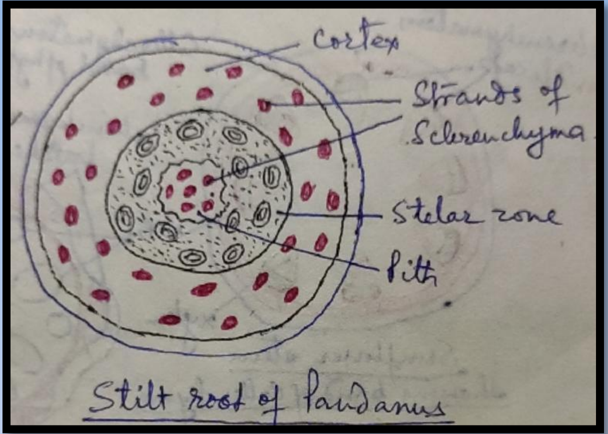
Examples are stilt root of ***Pananus***, prop root of maize, rhizome of Juncus etc. To sustain this strain, plants develop mechanical tissues at the central core.

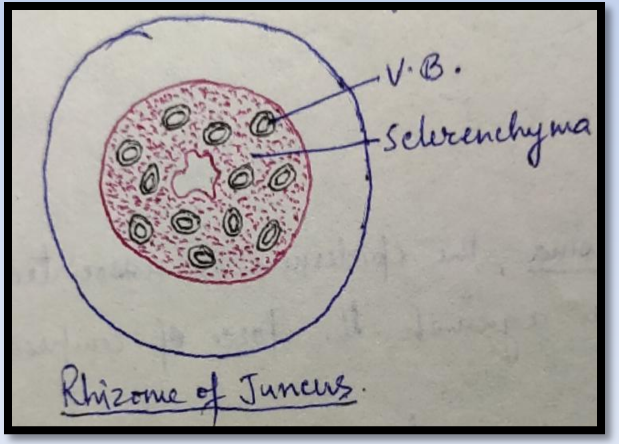


C. Incompressibility

In this type of stress, longitudinal compression is subjected to long axis of trees, radial compression to subterranean and aquatic organs.

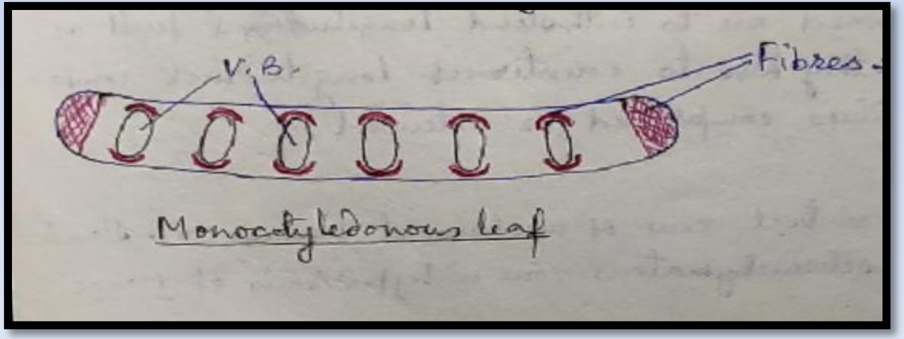
Examples are central wood in trees, sclerenchyma in hypodermis of maize and ***Pandanus***, sclerenchymatous pith in orchids, aroids. In plants like ***Sagittaria, Alisma***, epidermis and cortex is tightly packed to sustain the force of compression.

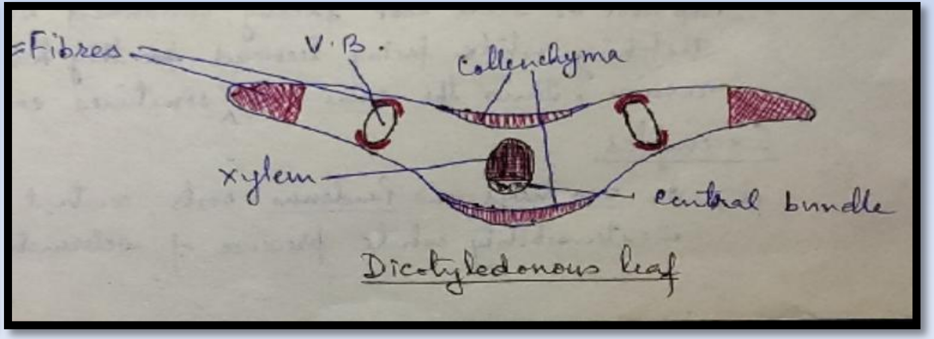




D. Shearing stresses

The flat organs like leaves of terrestrial or hydrophytic plants are often subjected to shearing stresses due to force of air or water. These forces act at right angle to the flat surfaces. This causes laceration. Margins of leaves are also affected. Monocots are more affected due to parallel venation. Dicots protect by developing fibres at margin and collenchyma at midrib.





Generally in monocots like Typha, many parallel vascular bundles with fibrous bundle caps are found. In this way, they represent multiple ‘I’ girder system. In xerophytic plants like Pinus and Nerium collenchymatous as well as sclerenchymatous patches are found below epidermis. Sometimes’T’ shaped prop cells are found in Osmanthus.