Hello students, I welcome you all for today's presentation. I am Dr. Mehtab Bukhari, Professor of Botany at Government College of Arts, Science and Commerce, Quepem, Goa.

The program is Bachelor of Science, First Year B.Sc, subject Botany, Semester Two, course code is BOC- 102 and the course title is Biodiversity II (it includes Vascular Plants).

The title of the unit is gymnosperms and the module name is anatomy of *Cycas.*

The outline includes anatomy of root, stem and leaf of *Cycas*.

On completion of this module, students understand, the anatomy of roots, stem and leaf of *Cycas* and, will be able to give the comparative account of normal and coralloid root of *Cycas.*

Students in the previous module, we have seen the morphology of *Cycas*. Now let us see the anatomy of *Cycas*.

The sporophytic plant of *Cycas* is differentiated into root, stem and leaves.

The leaves from a crown at the apex of the stem. Each leaf is megaphyllous, green having two distinct portion, a central stout axis known as rachis with needle like or elongated lanceolate leaflets arranged around the central axis.

In this module I will explain the anatomy of normal root and coralloid root of *Cycas,* young stem and old stem, leaflet of *Cycas* and rachis of *Cycas.*

Let us begin with the anatomy of normal root of *Cycas.*

Internally, the *Cycas* normal root consists of three well defined regions. The outermost layer known as a epiblema which is one celled in thickness, made up of compactly arranged thin walled cells, following the epiblema is the 2nd region known as Cortex, which is multi-layered in thickness, made up of thin walled parenchymatous cells. Some of these cells encloses tannin filled

cells. The cortical region surrounds the central stele comprising of one celled thick endodermis followed by one celled thick pericycle which surrounds the vascular tissues like xylem and phloem.

The steel is triarch in nature and it is exarch with metaxylem elements in the center and protoxylem towards the periphery.

Cycas coralloid roots are negatively geotropic , dichotomously branched and are inhabited by blue green algae, and they are coral like in appearance.

When we take the transverse section of this root of *Cycas* It appears circular in outline and shows three well defined regions periderm, cortex and stele.

The outermost layer is periderm made up of cork and cork cambium. Following the periderm is the wide cortical zone, which is differentiated into outer cortex, middle cortex, an inner cortex

The cells of outer cortex are thin walled and some of the cells are filled with tannin, while the middle cortex cells are elongated and are filled with filaments of blue green algae such as anabaena and nostoc, which helps in fixing nitrogen.

The cortical region surrounds the central stele which is triarch and exarch in nature. The stele encloses one celled thick endodermis followed by once celled thick pericycle which surrounds xylem and phloem.

Here is the leaflet of *Cycas* showing revolute margins.

The T.S. of leaflet of *Cycas* shows upper epidermis and lower epidermis. The epidermal cells are compactly arranged and are covered with thick cuticle. The stomata are restricted only to the lower epidermal layer and not present on the upper epidermis. Following the epidermis is the hypodermis made up of thick walled sclerenchymatous cells and are two to three layered in the middle region and single layered in the lamina region. Hypodermis is followed by mesophyll region

differentiated into upper palisade and lower spongy tissues. The Palisade cells are compactly arranged, elongated, and are filled with chloroplast. The mesophyll tissues showing spongy tissues are loosely arranged and filled with chloroplasts. In between the palisade and spongy tissues are present laterally elongated cells known as transfusion tissues which helps in lateral conduction. The centre is occupied by vascular bundle, it is restricted to the midrib region.

Here is enlarged view of single vascular bundle of Cycas leaflet. It shows diloxylic xylem having metaxylem, protoxylem, and isolated metaxylem. It is surrounded by bundle sheath cells.

Coming to the rachis of *Cycas*. Rachis is the central stout portion around which the leaflets are seen arranged in alternate or opposite manner.

When we take the transverse section of this portion- the rachis, it appears biconvex in outline. On the anterior side, we can see two gaps which is due to the development of leaflets arising on either side of the rachis. The vascular bundles are arranged in the form of inverted letter Omega.

When we take the enlarged portion of a part of this rachis, it appears like this. It shows outermost single layered epidermis made up of compactly arranged cells covered with cuticle and interrupted by stomata. Following the epidermis is hypodermis comprising of two layers of chlorenchymatous cells, loosely arranged, which is followed by thick walled sclerenchymatous hypodermis around the ground tissue region- made up of thin wall parenchymatous cells. The ground tissue region encloses a large number of vascular bundles and mucilage canals and, the xylem here is diploxylic in nature

This is the single vascular bundle seen in the rachis of *Cycas.* Each bundle has bundle sheath cells around it. The vascular bundles are conjoint , collateral and open type.

The arrangement of xylem elements shows variation at the base, in the middle and at the apex of the rachis, At the base it is endarch in nature, in the middle it is pseudo-mesarch, whereas at the apex it is exarch in nature, so it shows variation at the base, middle and apex of the rachis.

Coming to the anatomy of young stem of *Cycas* . It appears wavy in outline due to presence of woody leaf bases. The *Cycas* young stem shows three well defined regions, epidermis, cortex and stele. Epidermis is the outermost layer made up of thick walled compactly arranged cells. Following the epidermis is a wide cortical zone made up of thin walled parenchymatous cells enclosing large number of leaf traces and mucilage canals. The cortical region encloses a number of vascular bundles arranged in the form of a ring like manner. Each vascular bundle is conjoint, collateral, and open type, and it is endarch in nature with protoxylem in the center and metaxylem towards the periphery, The center is occupied by pith made up of thin walled parenchymatous cells enclosing mucilage canals.

These are the two types of leaf traces seen in the section of *Cycas* stem and, the two types of leaf traces are straight type and girdled type.

Coming to the anatomy of old stem of *Cycas* it appears wavy in outline due to the presence of woody leaf bases. The secondary growth in *Cycas* old stem begins with the activity of cambium. The interfascicular and fascicular cambium join hands forming a complete ring of cambium which cuts off secondary phloem towards outer side and secondary xylem towards the inner side. In this way, a number of concentric rings of secondary vascular tissues are formed by the activity of cambium. In the center. we have the pith made up of thin walled parenchymatous cells enclosing a large number of mucilage ducts. The cortical region followed by epidermis also encloses a large number of leaf traces and mucilage canals.

These are the books referred for preparing the e-content.

Thank you, students.