I'm Jyosna Gawas, Assistant professor in Botany at Government College of Arts, Science and Commerce, Sanquelim. In this module I'm going to talk about anomalous secondary growth in stem of *Boerhaavia* which is a subunit in Unit 3 i.e. secondary growth.

In this module I'm going to talk about anomalous secondary growth, reasons for deviation in the normal pattern of secondary growth, overview of primary anatomical structure of *Boerhaavia* stem and anomalous secondary growth in *Boerhaavia* stem. At the end of this module you will be able to define anomalous secondary growth and describe anomalous secondary growth in *Boerhaavia* Stem.

Anomalous secondary growth is defined as a deviation from normal pattern of secondary growth resulting in the formation of secondary tissues.

Anomalous secondary growth could be due to anomalous position of vascular cambium, abnormal behaviour of normal cambium, successive cambium, included phloem, presence of medullary bundles, presence of cortical bundles, intraxylary phloem, secondary growth in monocots or anomalous primary growth. In *Boerhaavia* stem, Secondary growth is showing deviation due to the presence of medullary bundles present in the ground tissue. In transverse section, young stem of *Boerhaavia* shows the following

parts. The transverse section is wavy in outline and is covered by a single layer of epidermis. Towards the outer side of the epidermal layer there is a thick cuticle and it shows presence of multicellular hair. Epidermis is followed by cortex which is differentiated into outer Collenchymatous cortex and inner chlorenchymatous cortex. The innermost cortical layer forms the endodermis. Endodermis is followed by a layer of pericycle and in the centre embedded into the ground tissue you will find vascular bundles. Vascular bundles are conjoint, collateral and open type and these are arranged in three rings. Outer ring, middle ring and the innermost ring. The outer ring comprises of many vascular bundles, middle ring comprises of 6 to 14 bundles and the innermost ring comprises of only two vascular bundles which are relatively larger in size. In the centre there is a small pith. Secondary growth in *Boerhaavia* stem occurs in the outer ring of vascular bundles.

In between the vascular bundles in the outer ring, interfascicular cambium develops. The fascicular cambium and the interfascicular cambium

joins together to form a cambial ring. The cambial ring

formed in the outer ring of vascular bundle produces secondary

phloem towards the outer side in the fascicular region and in the Interfascicular region it

produces parenchyma whereas

towards the inner side in the fascicular region it

produces secondary Xylem and in the Interfascicular region it

produces lignified conjunctive

tissue. As secondary growth advances primary phloem towards

the outer side and secondary phloem which was present towards

the inner side gets crushed. The cambial ring in the outer ring

of vascular bundle seizes its activity after some time.

Later a new cambial ring is

formed outside the secondary phloem and it produces

secondary vascular tissues.This cambial ring, which

is formed outer secondary phloem

is called as the first accessory cambium. The first accessory cambial

ring produces Xylem towards the inner side and phloem towards

the outer side.

The first accessory cambial ring also seizes its

activity after division producing secondary tissues and a new cambial ring

is formed. Similarly four or more accessory cambial rings are

formed producing vascular tissue. In this particular image

you can see that this is the first cambial ring

producing secondary tissues, next to it is the accessory cambium

ring which is developed later and this produces

secondary vascular tissue. Similarly there will be other

layers formed outside the first accessory cambial ring.

Interfascicular cambium interfascicular cambium is not

formed between the middle ring and the inner ring vascular

bundles. The middle ring and the inner ring vascular bundles

produces very little amount of secondary tissues due to the

presence of fascicular cambium present in between the vascular

tissues. As secondary growth

advances phellogen is formed in the outer cortical layers.

This produces phellem towards the outer side and phelloderm

towards the inner side. So at the end of secondary growth, the

outermost epidermal layer will be replaced by a new protective

layer, which is called as periderm. Inside to that you

will have accessory cambial rings and in the center you will

find the medullary bundles. These are the list of references which I've used to

prepare this module. Thank you for your attention.