PUC first year-semester 2

UNIT – IV. INTERNAL ORGANIZATION IN PLANTS

MODULE 24: SECONDARY GROWTH IN DICOT STEM AND DICOT ROOT

INTRODUCTION

Growth is an irreversible increase in size accompanied by increase in dry weight. Growth is of two types. The normal process of growth that occurs in every plant body is known as primary growth. In gymnosperms and dicotyledonous plants, there is a process of growth that begins after a known period of primary growth. Such a growth is known as secondary growth. It involves the activity of secondary meristem (lateral meristem). It results in the formation of secondary permanent tissues such as secondary xylem, secondary phloem and secondary cortex. Secondary growth brings about an increase in the girth or diameter of the plant body. There is no normal secondary growth in monocotyledons plants due to the absence of secondary meristems.

SECONDARY GROWTH IN A DICOT STEM

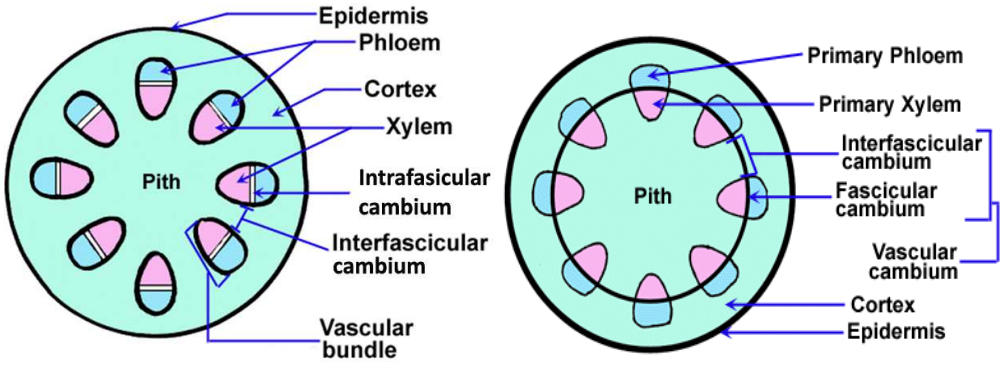
In a dicot stem, secondary growth occurs both in the stele and extra stelar regions. The process occurs simultaneously in both the regions but is caused by separate strips of secondary meristems (lateral). In the stele, secondary growth is initiated by vascular cambium, while in the cortex, it is initiated by cork cambium.

SECONDARY GROWTH IN THE STELE

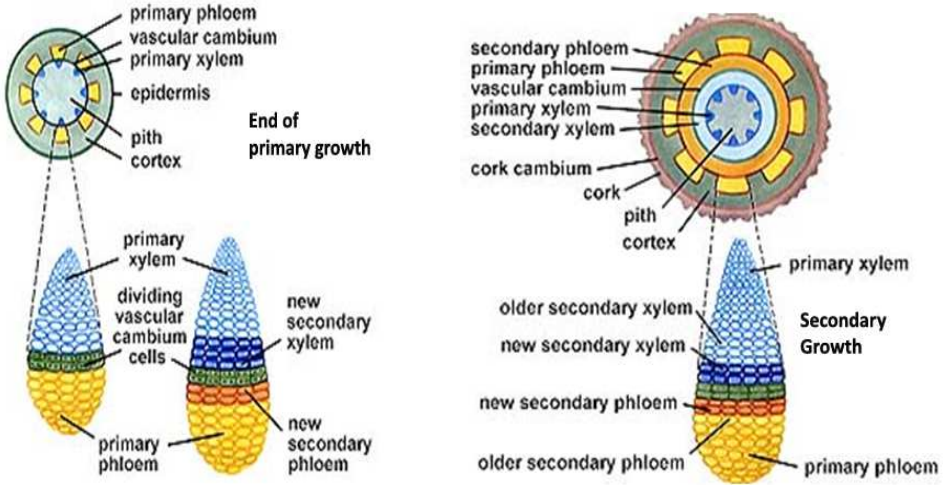
It is the result of the activity of the vascular cambium, which occurs in between xylem, and phloem of each vascular bundle. Hence, it is also known as intra-fascicular cambium. In addition, towards the beginning of secondary growth there is a process of dedifferentiation in some of the parenchyma cells of the medullary rays, adjoining the vascular cambium. As a result,

these cells now become meristematic and represent the inter-fascicular cambium. The meristematic cells in the intra-fascicular cambium and inter-fascicular cambium fuse and result in the formation of a continuous strip of meristem called cambial ring. The cambial ring consists of two types of initials called fusiform initials (in intra fascicular cambium) and ray initials (in inter fascicular cambium). The cambial ring at this stage has primary xylem on its inner surface and primary phloem on its outer surface.

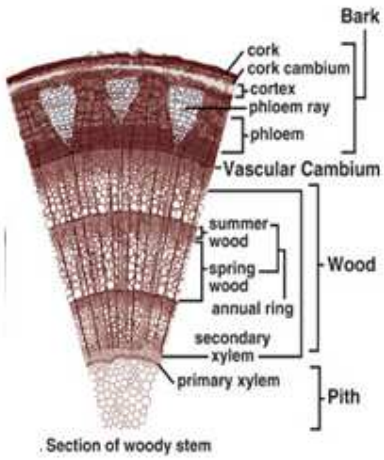
Formation of cambial ring in the dicot stem



The mitotic activity of the cambial ring is purely seasonal. It occurs only twice during every year, once in the spring and once in the autumn. Thus, every year two sets of secondary xylem and two sets of secondary phloem are formed. Each year, the mitotic division of the cambial ring usually begins in the spring season. The secondary xylem or wood that is formed in the spring season is therefore known as springwood or early wood, while the secondary xylem formed in the autumn is known as autumn wood or late wood. The spring wood is lighter in colour and has lower density whereas the autumn wood is darker and has higher density.



The two distinct layers of secondary xylem, the inner springwood and the outer autumn wood together represent a growth ring (or annual ring). One such annual ring is added every year due to the secondary growth. Thus, it is possible to ascertain the age of a dicot tree by counting the number of annual rings. Ascertaining the age of a tree by counting the number of annual rings is called **"**dendrochronology**"**.



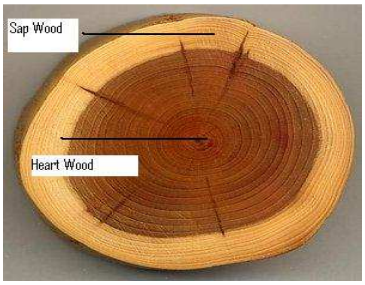
Thus, the secondary growth in the stele results in the formation of secondary xylem and secondary phloem. Due to the addition of these tissues, there is an increase in the girth of the stele.

After a considerable period of continuous secondary growth, several changes take place in the secondary xylem. In a much older stem, the secondary xylem (wood) shows two regions namely duramen and alburnum.

Duramen, also known as heartwood, represents the centrally located, inactive portion of the secondary xylem. It appears dark in colour due to the accumulation of pigments resulting from oxidation of organic compounds like oils and tannins and formation of tyloses. It is incapable of conducting water and provides only mechanical support to the trees. It is this part of the secondary xylem that is used as the commercial wood.

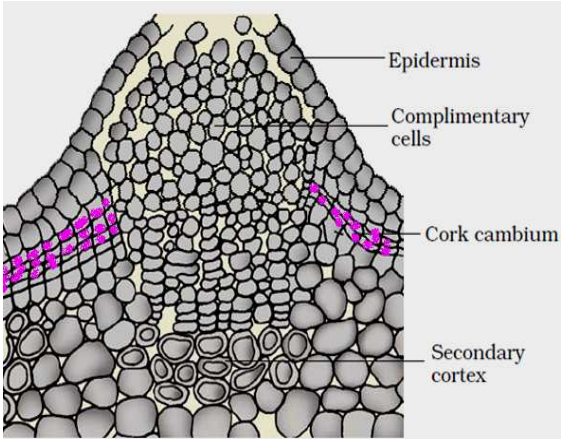
Alburnum, also known as sapwood, represents the peripheral, active portion of the secondary xylem. This portion is still physiologically active and is capable of conducting water. Due to its meager mechanical strength and lack of durability, the sapwood cannot serve as commercial wood.

T.S of wood showing growth rings



SECONDARY GROWTH IN THE EXTRASTELAR REGION

It is the result of the activity of a secondary meristem called cork cambium, which appears between hypodermis and primary cortex. Some of the parenchyma cells in the peripheral layers of cortex undergo dedifferentiation and become meristematic. These cells now represent the cork cambium or phellogen. The cork cambium starts exhibiting mitotic activity on both the sides, just as the cambial ring in the stele. However there is no differentiation of different types of initials in cork cambium.

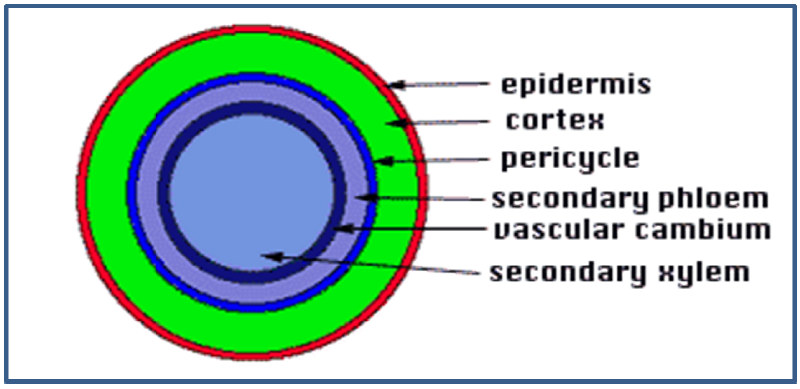


The mitotic activity on the inner surface of the cork cambium results in the formation of cells, which undergo differentiation into a living tissue, called secondary cortex or phelloderm, just above the primary cortex. The mitotic activity on the outer surface results in the formation of cells, which undergo differentiation into a dead tissue, called cork or phellem, just below the epidermis. The cork covers and masks the hypodermis. The tissue resulting from secondary growth in the cortex and the cork, the cork cambium and the secondary cortex-together represent a region called periderm. The cells of the cork are light in weight and their walls are thickened with suberin. The cork is impervious to water and gases. Some non-suberized cork cells are called phelloids. The cork is commercially used as bottle stoppers (eg: *Quercus*). All the tissues outside the vascular cambium is known as bark i.e., it consists of periderm, primary cortex, pericycle, primary phloem and secondary phloem. The bark is also commercially important. eg: cinnamomum.

The periderm along with the primary cortex represents the bark. In several dicot plants, the bark peels off regularly.

SECONDARY GROWTH IN DICOT ROOTS

In dicot roots, the conjunctive tissue below the phloem dedifferentiates into meristem; later the portion of pericycle exterior to protoxylem becomes meristematic. These strips formed at different stages unite to form a wavy cambium ring which later forms into circular cambial ring that behaves just like the cambial ring of stem and subsequent events are similar to that of stem. It increases in girth of the roots by the production of secondary xylem, phloem and periderm. These tissues especially the periderm – stop the absorption of water. In roots, however the secondary growth is less extensive than in stems.



Check points

- Growth is an irreversible increase in size accompanied by increase in dry weight.
- Growth is of two types- primary and secondary.
- The normal process of growth that occurs in every plant body is known as primary growth.
- The process of growth that begins after a known period of primary growth is known as secondary growth. It involves the activity of secondary meristem (lateral meristem).

- The secondary growth brings about an increase in the girth or diameter of the plant body.
- There is no normal secondary growth in monocotyledons plants due to the absence of secondary meristems.
- In a dicot stem, secondary growth occurs both in the stele and extra stelar regions.
- Secondary growth in the stele is the result of the activity of the vascular cambium, which occurs in between xylem, and phloem of each vascular bundle.
- Continuous strip of meristem called cambial ring is formed.
- The mitotic activity of the cambial ring is purely seasonal. It occurs only twice during every year, once in the spring and once in the autumn.
- Thus, every year two sets of secondary xylem and two sets of secondary phloem are formed.
- The two distinct layers of secondary xylem, the inner springwood and the outer autumn wood together represent a growth ring (or annual ring).
- Secondary growth in the extra stelar region is the result of the activity of a secondary meristem called cork cambium, which appears between hypodermis and primary cortex.
- In roots, the secondary growth is less extensive than in stems.

Short answer Questions:

1. What are the two types of tissue produced by the vascular cambium?
2. Differentiate between spring wood and autumn wood?
3. How are annual rings formed? What is their importance?
4. Write an account of

(a) Duramen and (b) Alburnum

5. Give a brief account of periderm.
6. What is cork tissue? Give its functions.
7. How secondary xylem and phloem are formed?
8. What are activities of cambial tissue?
9. How the secondary cortex is formed?
10. Differentiate between

(a) Phelloderm and (b) Phellem

Long answer Questions:

1. Describe secondary growth in stem with well labeled diagram.
2. Write in detail about the secondary growth in root.

MCQS

1. The lighter-colored wood in a tree that conducts water is

A. Sapwood

B. Heartwood

C. Springwood

D. Consists of primary xylem only

2. Additional vascular tissue produced as secondary growth in a root or stem originates from which cells?

A. Vascular cambium

B. Phloem

C. Apical meristem

D. Xylem

E. Endodermis

3. Bark

A. Is composed of phloem plus periderm

B. Is associated with annuals but not perennials

C. Is formed by apical meristems

D. Has no identifiable function in trees

E. Forms annual rings

4. A plant has the following characteristics: a tap root system; reticulate leaf veins; thick, lignified cell walls; and a vascular cambium. Which of the following best describes the plant?

A. Woody monocot

B. Herbaceous monocot

C. Herbaceous dicot

D. Woody dicot

5. Which of the following is true about secondary growth in plants?

A. Primary growth and secondary growth alternate in the life cycle of a plant.

B. Plants with secondary growth are typically the smallest ones in an ecosystem.

C. Secondary growth is a common feature of monocot stem

D. Secondary growth is produced by both the vascular cambium and the cork cambium.

6. The conducting tissue formed when the stem grows old is mainly composed of

A. Primary xylem

B. Phloem

C. Secondary xylem

D. Secondary phloem

7. The vascular system of a three-year-old dicot stem consists of

A. 2 rings of xylem and 2 of phloem

B. 3 rings of xylem and 1 of phloem

C. 3 rings of xylem and 3 of phloem

D. 2 rings of xylem and 1 of phloem

8. You can determine the age of a mango tree by counting the annual rings of _____ formed by the _____.

A. primary xylem/apical meristem

B. secondary phloem/vascular cambium

C. dermal tissue/cork cambium

D. secondary xylem/vascular cambium

9. The most abundant cell type in periderm is:

A. Parenchyma

B. Collenchyma

C. Cork

D. Vessel elements

E. Ray initials

10. The periderm of a woody plant is composed of this tissue.

A. Primary xylem

B. Secondary phloem

C. Secondary cortex

D. Vascular cambium