**Phloem**

It is the vascular tissue which is responsible for the transport of sugars from source tissues (ex. Photosynthetic leaf cells) to sink tissues ( flowers). The main components of phloem are:

**1-Sieve tube elements:** It the principal conducting cells of the phloem in angiosperm and characterized by:

**1-** The presence of **sieve plates**. The protoplasts of sieve-tube elements contain **P-protein** (phloem protein, formerly called slime).

**2-** The walls of sieve-tube elements commonly are described as primary and with standard microchemical tests usually give positive reactions for only cellulose and pectin.

**3-** In the **leaves of grasses**, sieve tubes, typically have relatively **thick cell walls** , In some species—***Triticum aestivum****,* these walls are **lignified**. Sieve plates may occur on side walls.

**4-** Some sieve plates bear only a single sieve area **simple sieve plate**, while others bear two or more **compound sieve plate**. The sieve pores typically are lined with the wall constituent **callose**.

**2- Companion cells:**

Specialized parenchyma cells associated with sieve-tube elements. Typically, companion cells are derived from the same mother cell as their associated sieve-tube elements, so that that the two kinds of cells are closely related ontogenetically. Companion cells are nucleate whilst sieve tube members are not. One or more companion cells may be associated with a single sieve-tube element. Typically the walls of companion cells are neither sclerified nor lignified, and commonly the companion cells collapse when their associated sieve-tube elements die. Sclerification of companion cells has been reported in non-conducting phloem of *Carpodetus serratus*. In the minor veins of mature leaves of many herbaceous eudicots, the companion cells possess irregular ingrowths of wall material, which is typical of transfer cells. the function of the companion cells seems in part to be regulation of the physiological activities of the sieve elements.

**3- Parenchyma cells:**

The phloem contains variable numbers of parenchyma cells other than companion cells .Parenchyma cells containing various substances, such as starch, tannins, and crystals, are regular components of the phloem. Crystal-forming parenchyma cells may be subdivided into small cells, each containing a single crystal, such chambered **crystalliferous** **cells** are commonly associated with fibers or sclereids and have lignified walls with secondary thickenings.

**4- Fibers:**

They are common components of both primary and secondary phloem, In

some plants, the fibers are typically lignified; in others, they are not. The pits in their walls are usually simple, but may be slightly bordered. The fibers may be septate or non-septate and may be living or nonliving at maturity. Living fibers serve as storage cells as they do in the xylem. Gelatinous fibers also occur in the phloem. In many species, primary and secondary fibers are long and are used as a commercial source of fiber (*Linum,* *Cannabis, Hibiscus*).

**Primary phloem:**

The primary phloem is classified into **prtophloem and meatphloem** on the same basis of xylem.

**A- Protophloem:**

It matures in plant parts that are **still undergoing extension growth**, and its sieve elements are stretched and soon become unfunctional. Eventually, they are completely obliterated

1- The sieve elements of angiosperms are usually narrow and inconspicuous but they are enucleate and have sieve areas with callose.

2- They may or may not have companion cells.

3- Fibers are found in the periphery of the phloem region in numerous dicot stems they also occur in roots.

**B- Metaphloem:**

It differentiate after organs elongation. In herbaceous dicot plants without secondary growth, constitutes the only conducting phloem in adult plant parts. While in woody or herbaceous plants with secondary growth is usually destroyed by secondary growth.

 **The main characteristics of metaphloem are:**

1- Sieve elements are wider than the protophloem.

2- Companion cells are regularly present in metaphloem.

3- Fibers usually absent.

4- Parenchyma cells are elongated and oriented, with their long axes parallel with the longitudinal extent of the vascular tissue. They may become sclerefied after the phloem ceases to conduct.

**Gymnosperm phloem**

In gymnosperms, the axial phloem consists of **sieve cells** and **parenchyma cells**, some of which become **albuminous cells**; some gymnosperms have **fibres** in the phloem as well. There is often very little wall thickening but **sclerification** can take place. The outermost phloem layers either become **compacted**, or are incorporated into the ‘bark’.

**Angiosperm phloem**

1- The **sieve areas** (which are areas of dense pitting in lateral walls of sieve cells) are a feature of the more primitive dicot.

2- **Well-organized sieve plates**, simple and transverse, situated at

end of the sieve tube members are considered to be advanced

3- **Companion cells** usually **much narrower** than the sieve tube member to whom they are adjacent, are a feature of dicot phloem.

**Secondary phloem:**

It is formed from **vascular cambium** just as **secondary xylem,** so it has **axial** and **ray system.**The **axial system** of secondaryphloem often **contains:**

**1-** The axial parenchyma may occur in parenchyma strands or as single fusiform parenchyma cells, idioblastic cells, sclereids and fibres.

 **2-** In some species, sclereids and fibres are absent from the functioning phloem, but differentiate at a later stage. Fibres often alternate, in bands, with conducting cells, for example in *Tilia* and various Malvaceae.