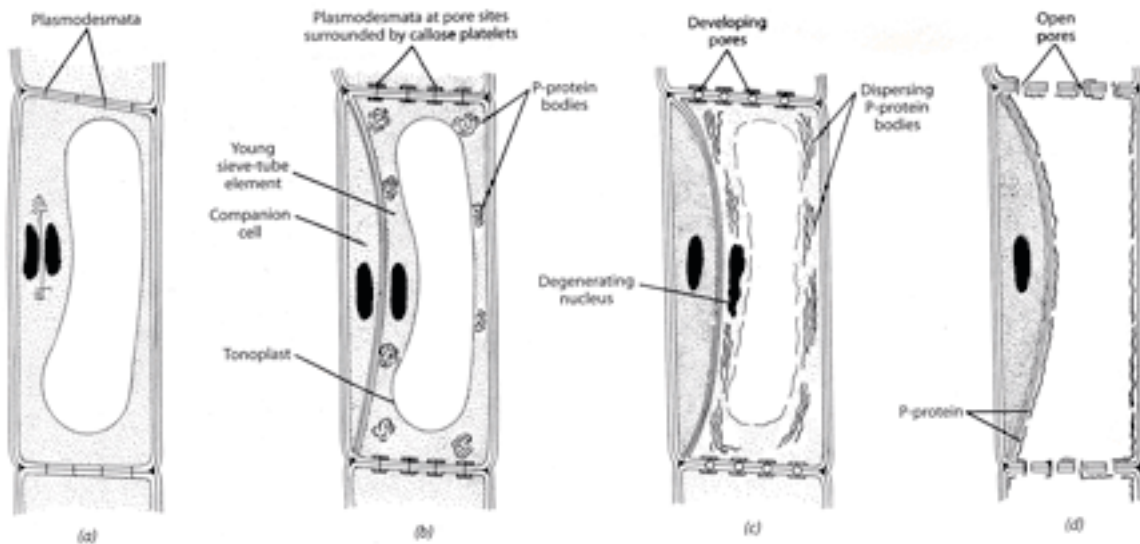


TRANSPORT IN THE PHLOEM

Sieve Elements Are Living, Functioning Cells At Maturity*

Unlike the elements of the xylem, which undergo a complete and total breakdown during differentiation and transport occurs through dead, empty cells, sieve elements are living cells, with cytoplasm, at functional maturity. The term “sieve” refers to the clusters of pores, the sieve areas, through which the cytoplasm of adjacent elements are interconnected. Most of the sieve areas are concentrated on the overlapping ends of the long sieve tube elements. The cytoplasm of sieve elements is unique, however. As the sieve element differentiates and matures, it undergoes a selective breakdown. The two major changes are the breakdown of the nucleus and the vacuolar membrane, but other changes occur as well: ribosomes, Golgi apparatus, and the cytoskeleton are lost, and all the remaining components become distributed along the wall. The plasma membrane, smooth endoplasmic reticulum, some plastids, and mitochondria remain.

Some sieve-tube elements possess a proteinaceous substance called **P-protein**, which also becomes distributed along the wall. In cut sections of phloem tissues, “slime plugs” of P-protein are usually found near the sieve plates. Slime plugs are believed to result from the surging of the contents of sieve tubes that are severed. Some botanists believe that P-protein helps seal the sieve-plate pores at the time of wounding.



Differentiation of a sieve-tube element: **(a)** The mother cell of the sieve-tube element undergoing division. **(b)** Division has resulted in formation of a young sieve-tube element and a companion cell. After division, one or more P-protein bodies arise in the cytoplasm, which is separated from the vacuole by a tonoplast. The wall of the young sieve-tube element has thickened, and the sites of the future sieve-plate pores are represented by plasmodesmata. Each plasmodesma is now surrounded by a platelet of callose on either side of the wall. **(c)** The nucleus is degenerating, the tonoplast is breaking down, and the P-protein bodies are dispersing in the cytoplasm lining the wall. At the same time, the plasmodesmata of the developing sieve plates are beginning to widen into pores. **(d)** At maturity, the sieve-tube element lacks a nucleus and a vacuole. All of the remaining protoplasmic components, including the P-protein, line the walls, and the sieve-plate pores are open. The callose platelets were removed as the pores widened. Not shown here but also present in the mature sieve-tube element are smooth endoplasmic reticulum, mitochondria, and plastids.

* Adapted from Raven, P., R. Evert and S. Eichorn, 1999. *Biology of Plants*, 6th edition. W. H. Freeman, New York.