

FIGURE 28. Characteristic details of a plant cell.

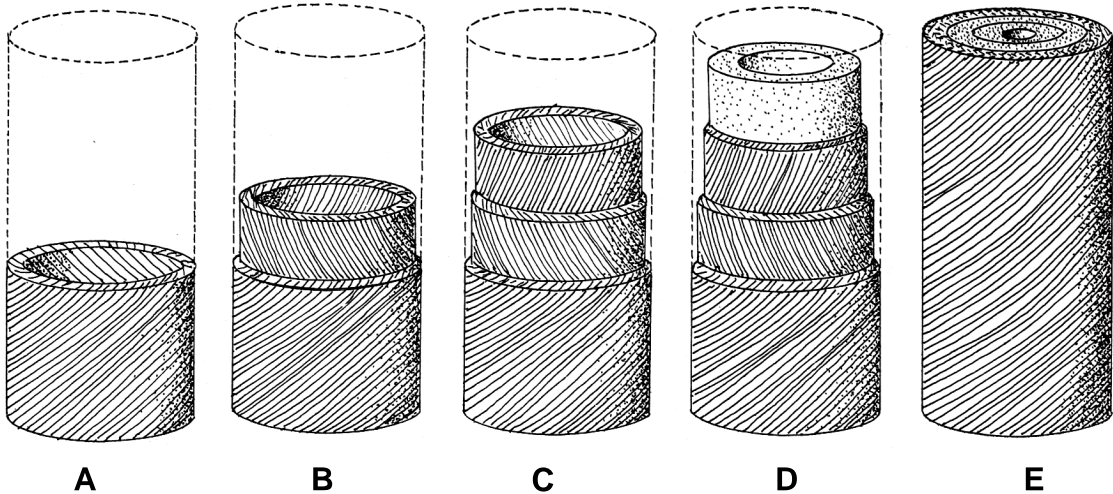
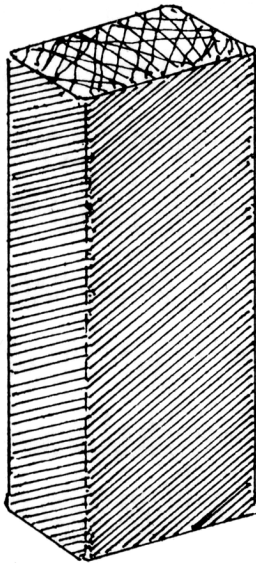
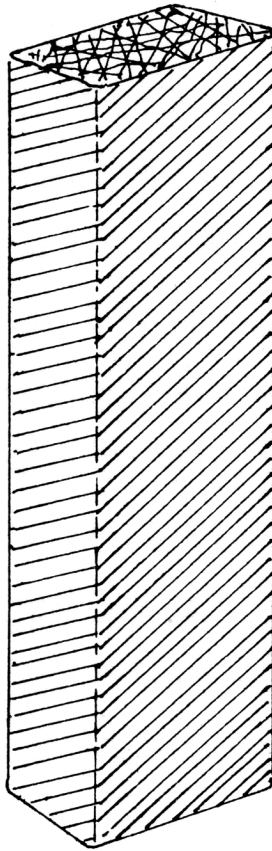


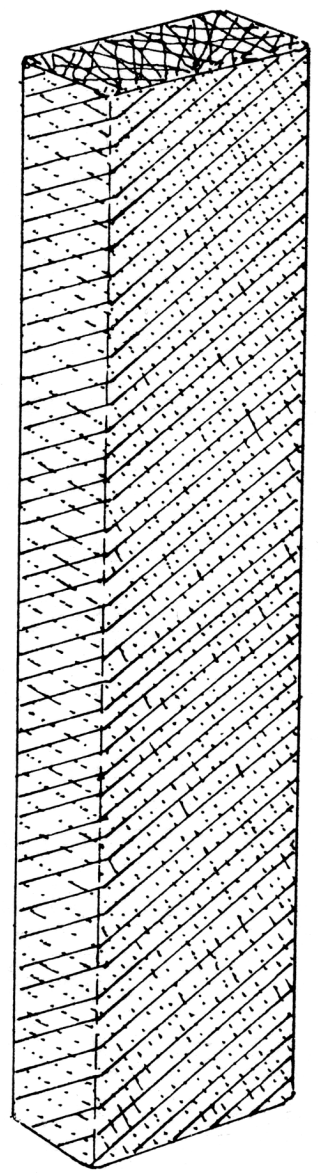
FIGURE 29. Thickening of a plant cell wall. (A) Cellulose microfibrils of the primary cell wall. The cavity at the center is occupied by the protoplasm. (B & C) Secondary wall thickening begins with additional layers of cellulose; each layer is laid down in a different direction. (D) A layer of lignin is added increasing the rigidity of the wall. (E) With the additional of a second layer of lignin, wall thickening is complete. The shrunken protoplasm dies.



a.



b.



c.

FIGURE 30. How cellulose microfibrils determine the direction of cell growth. (a) The side walls of a young cell have microfibrils arranged in parallel formation. (b) The cell elongates when microfibrils in the side walls spread apart due to pressures within the cell; the criss-cross pattern of end-wall microfibrils prevents the cell from growing in width. (c) After reaching its maximum length, secondary wall thickening prevents further growth in the cell's length.

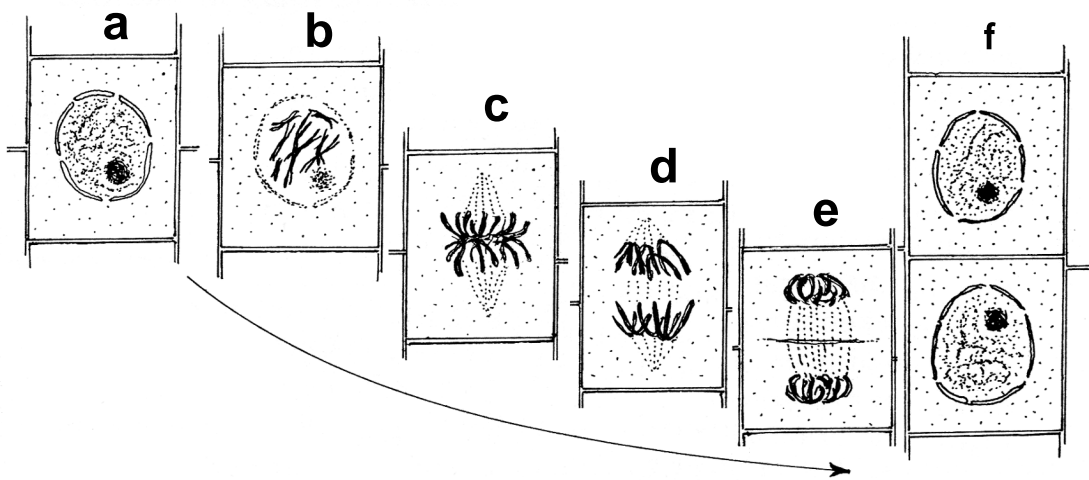
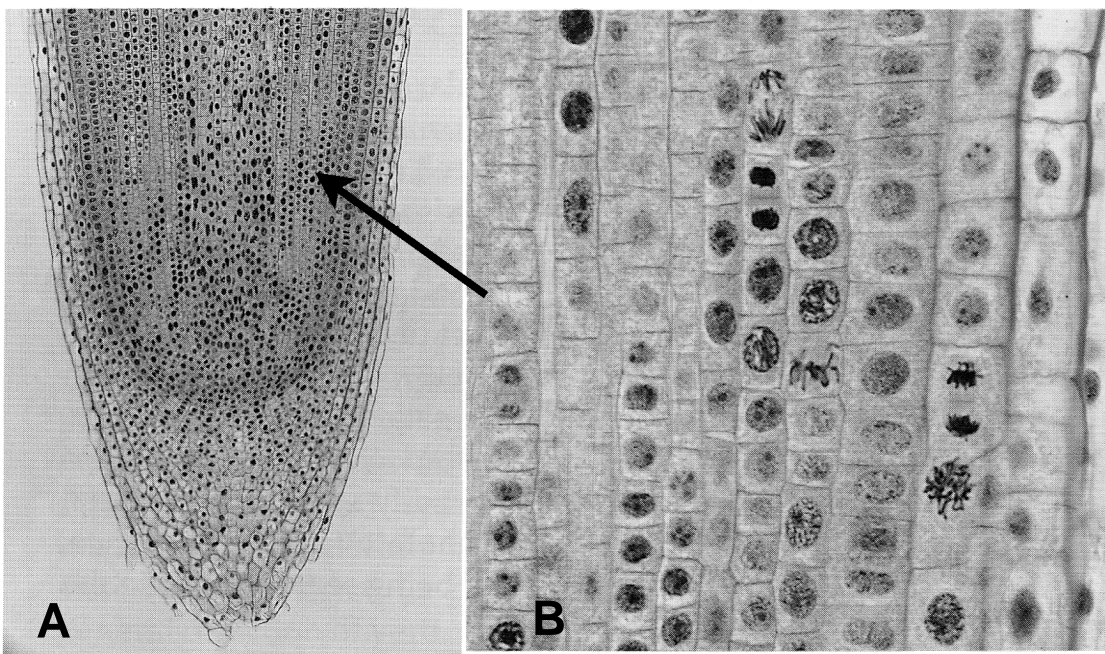


Figure 31. Cell division by mitosis. The root's apical meristem (A) is the U-shaped area a short distance from the tip. This is a region of active cell division by mitosis and various mitotic figures are observed under high magnification (B); specifically, mitosis is basically a way to divide the cell while assuring that each new cell has a full set of chromosomes. Stages include: Interphase (a); Prophase (b); Metaphase (c); Anaphase (d); Telophase (e); and a return to prophase by the two resultant daughter cells (f).

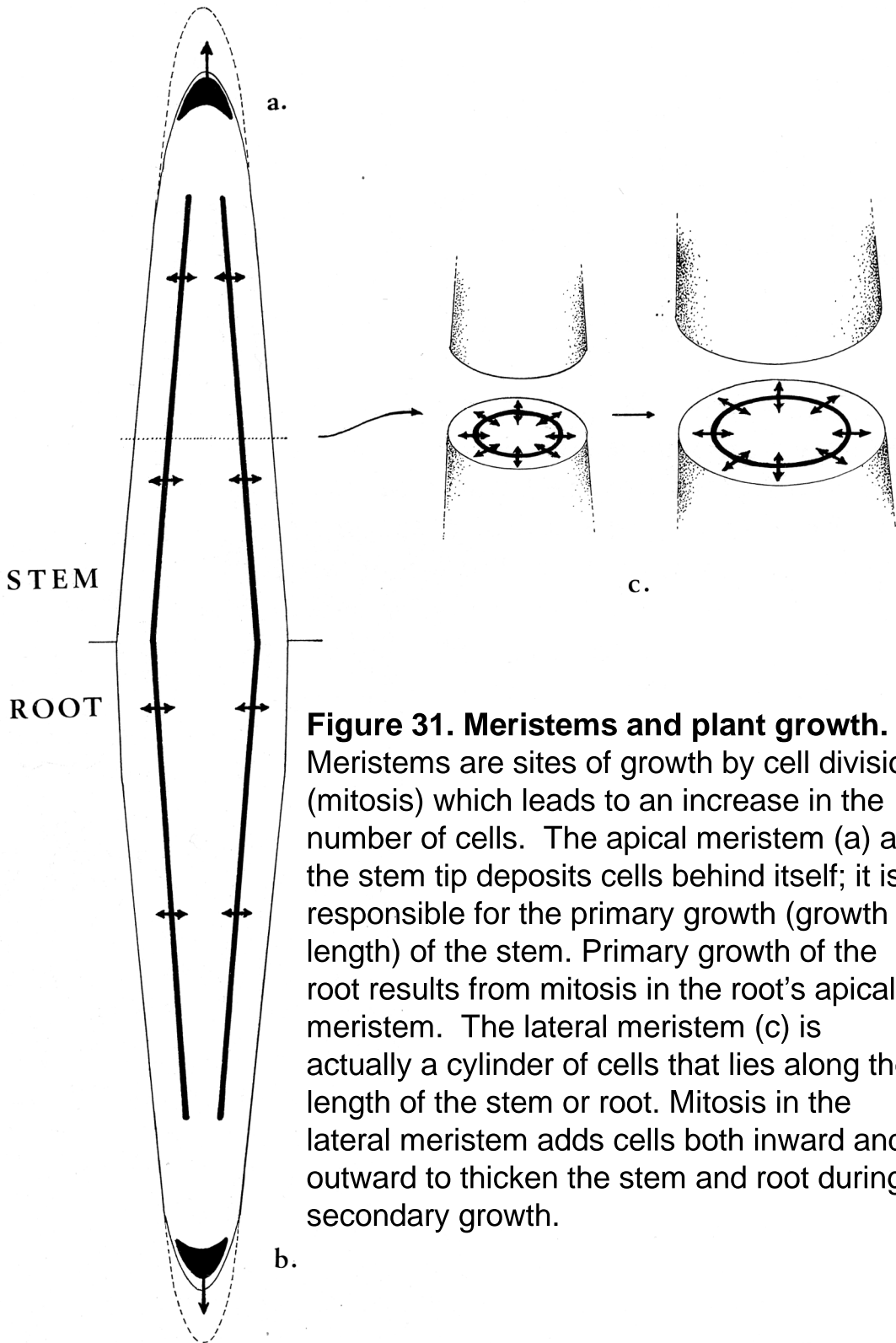


Figure 31. Meristems and plant growth. Meristems are sites of growth by cell division (mitosis) which leads to an increase in the number of cells. The apical meristem (a) at the stem tip deposits cells behind itself; it is responsible for the primary growth (growth in length) of the stem. Primary growth of the root results from mitosis in the root's apical meristem. The lateral meristem (c) is actually a cylinder of cells that lies along the length of the stem or root. Mitosis in the lateral meristem adds cells both inward and outward to thicken the stem and root during secondary growth.

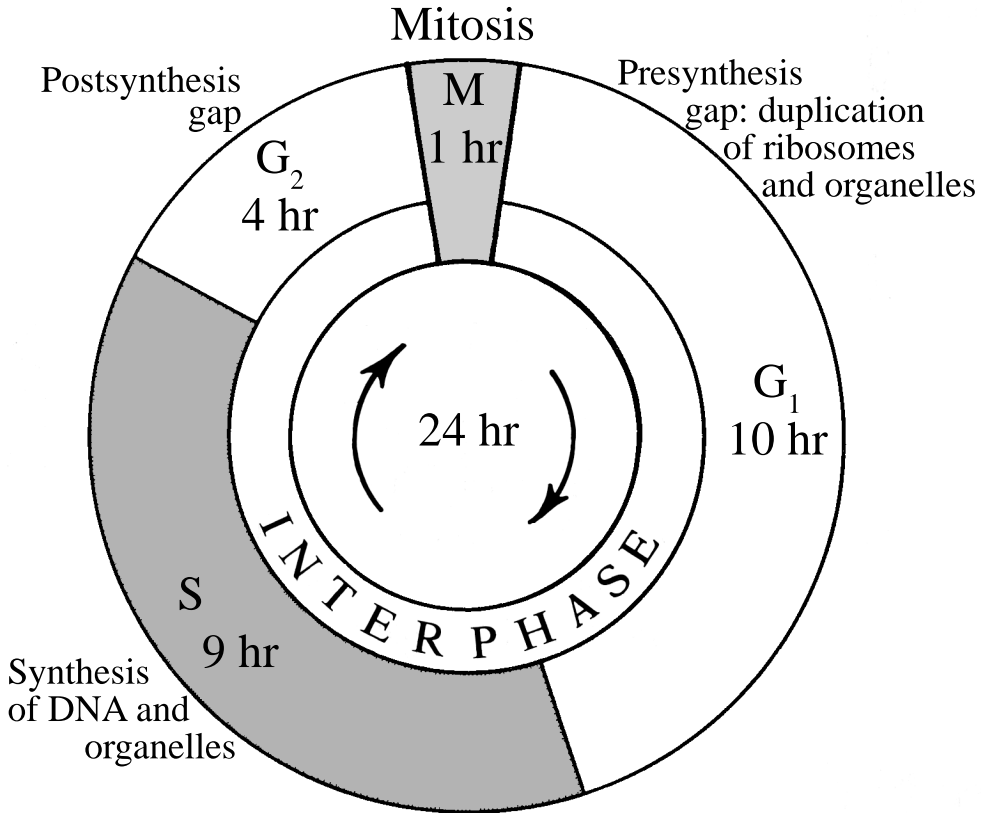
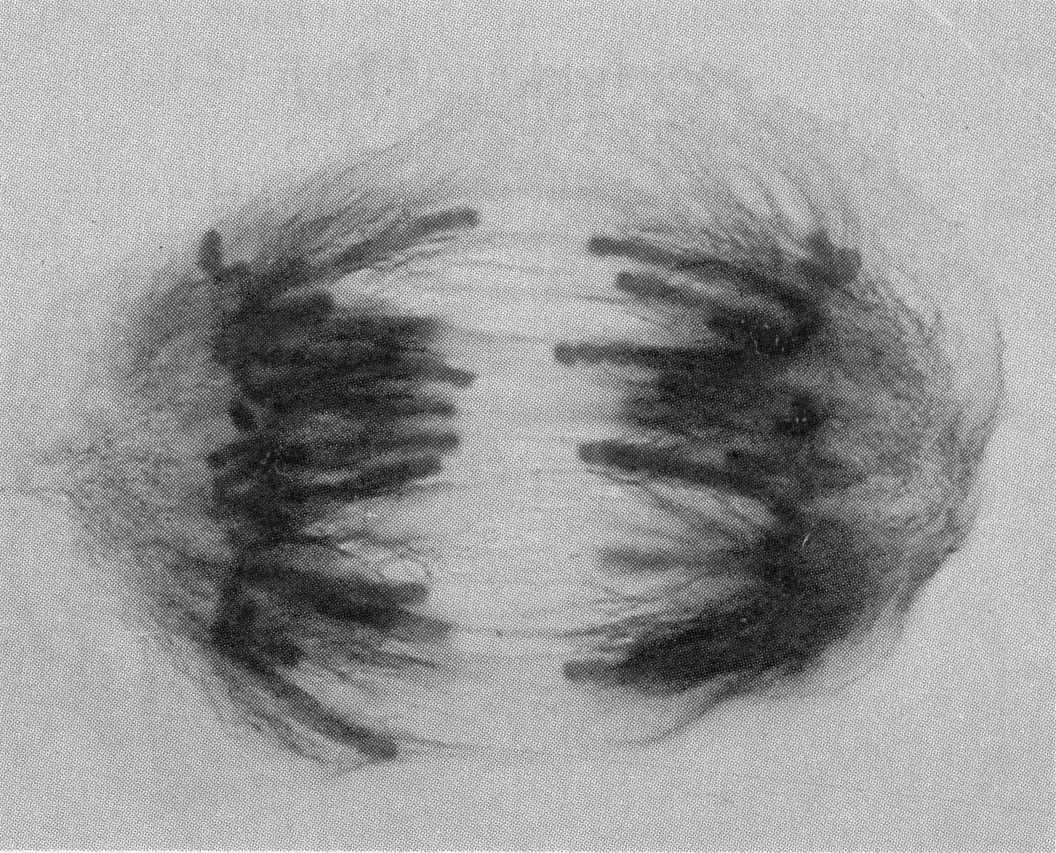


FIGURE 32. The cell cycle. This particular cycle assumes a period of 24 hours, but some cells complete the cycle in less time while others take many days. Similarly, although all cells pass through the same sequence of events, the time ratios of the 4 stages of the cycle vary, with G₁ exhibiting the most variation.



10 μm

FIGURE 33. Chromosomes in a dividing cell of the African blood lily. The separating chromosomes for the nuclei of each new cell are readily distinguished as they are separated by the fibers of the spindle apparatus.

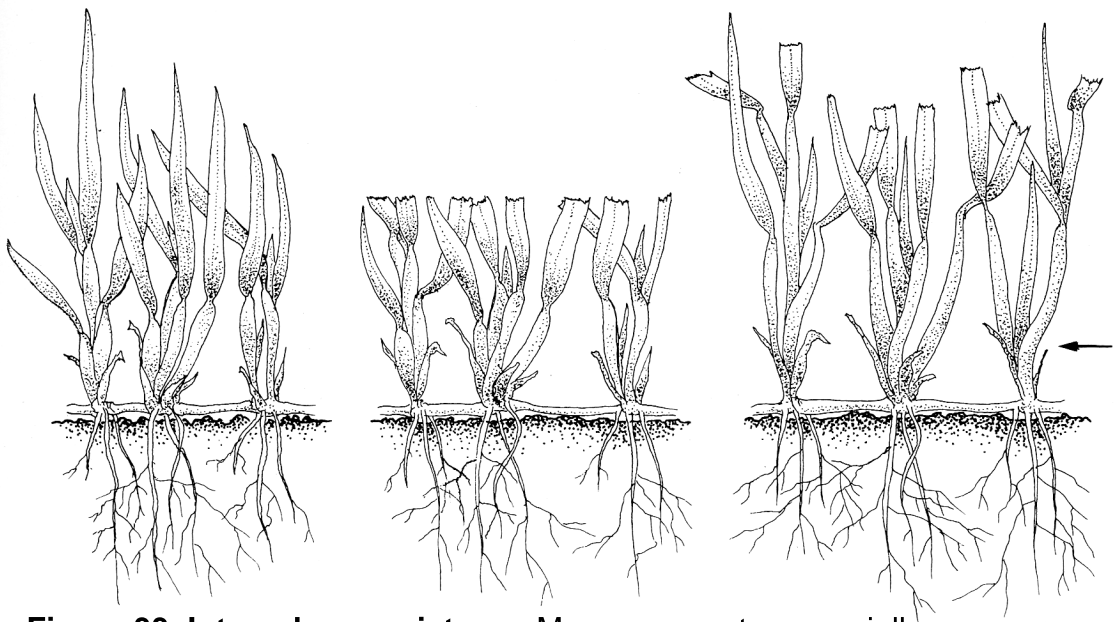


Figure 33. Intercalary meristems. Many monocots, especially grasses grow from intercalary meristems, located between the blades and the horizontal stem or tiller (arrow points to approximate location of intercalary meristem).

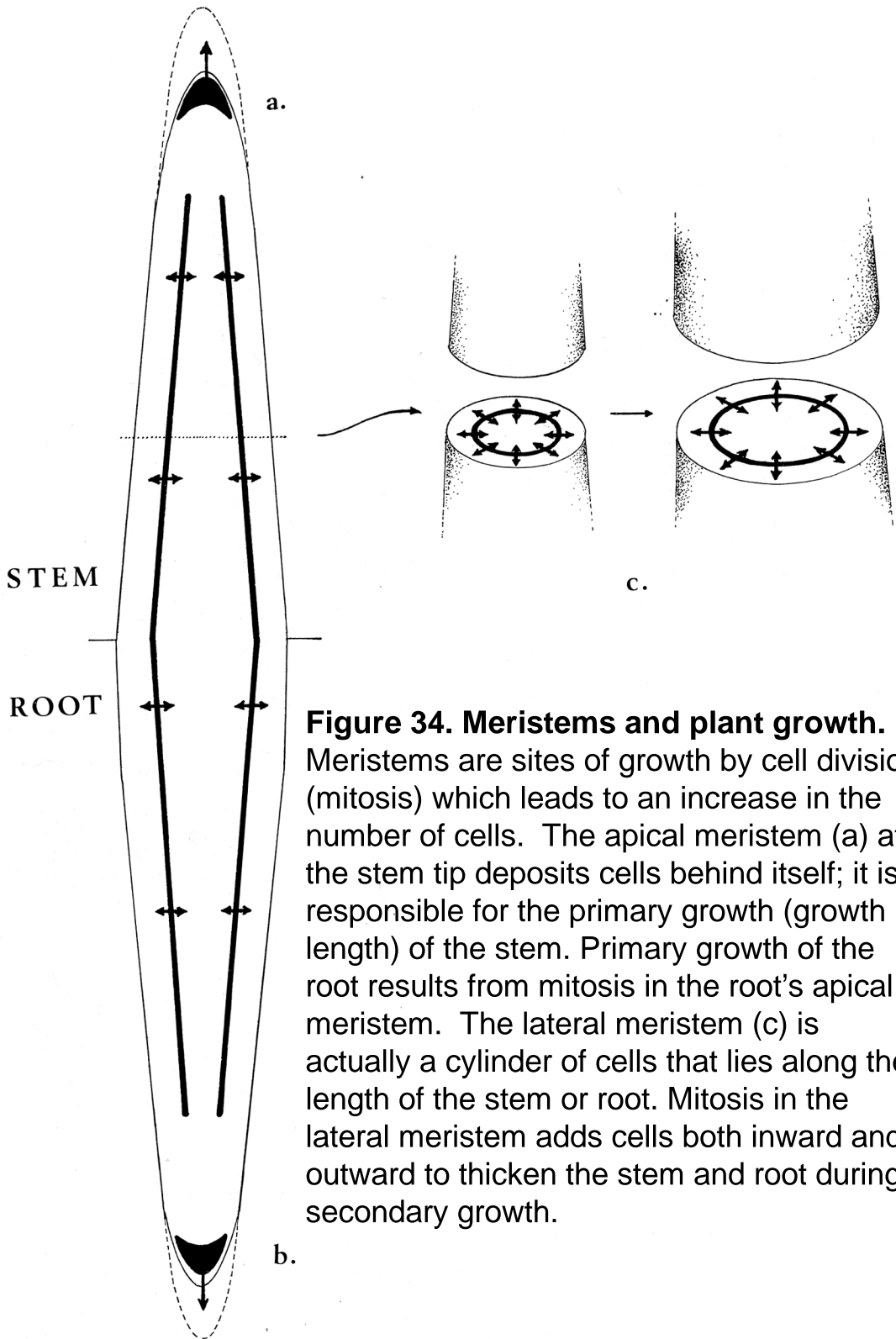


Figure 34. Meristems and plant growth. Meristems are sites of growth by cell division (mitosis) which leads to an increase in the number of cells. The apical meristem (a) at the stem tip deposits cells behind itself; it is responsible for the primary growth (growth in length) of the stem. Primary growth of the root results from mitosis in the root's apical meristem. The lateral meristem (c) is actually a cylinder of cells that lies along the length of the stem or root. Mitosis in the lateral meristem adds cells both inward and outward to thicken the stem and root during secondary growth.

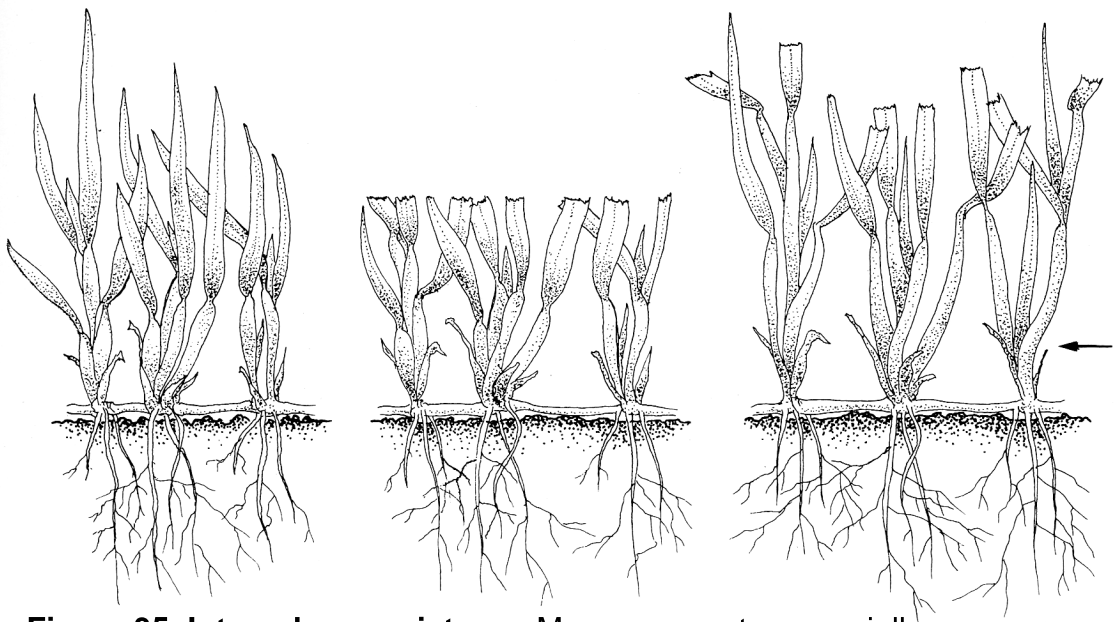


Figure 35. Intercalary meristems. Many monocots, especially grasses grow from intercalary meristems, located between the blades and the horizontal stem or tiller (arrow points to approximate location of intercalary meristem).

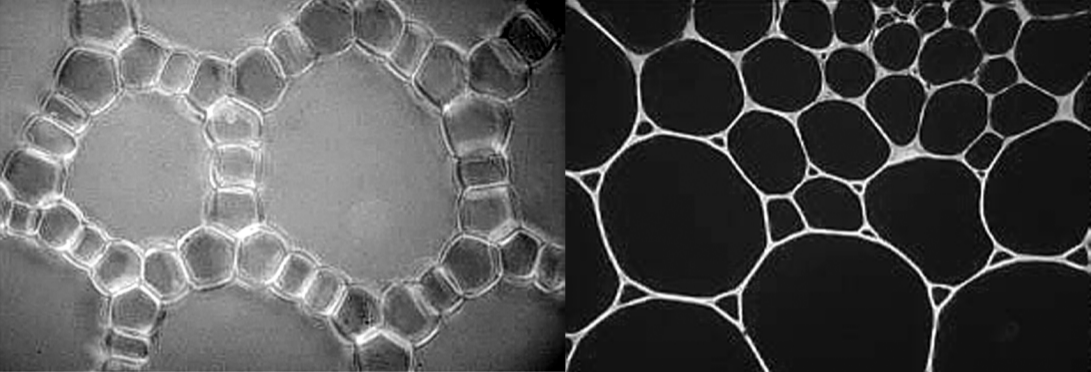


Figure 36. Parenchyma tissues. Two examples of parenchymal tissues forming air tubes in a rush stem (left) and base tissues in a fruit (right). Note the single primary cell wall and very large vacuole space.

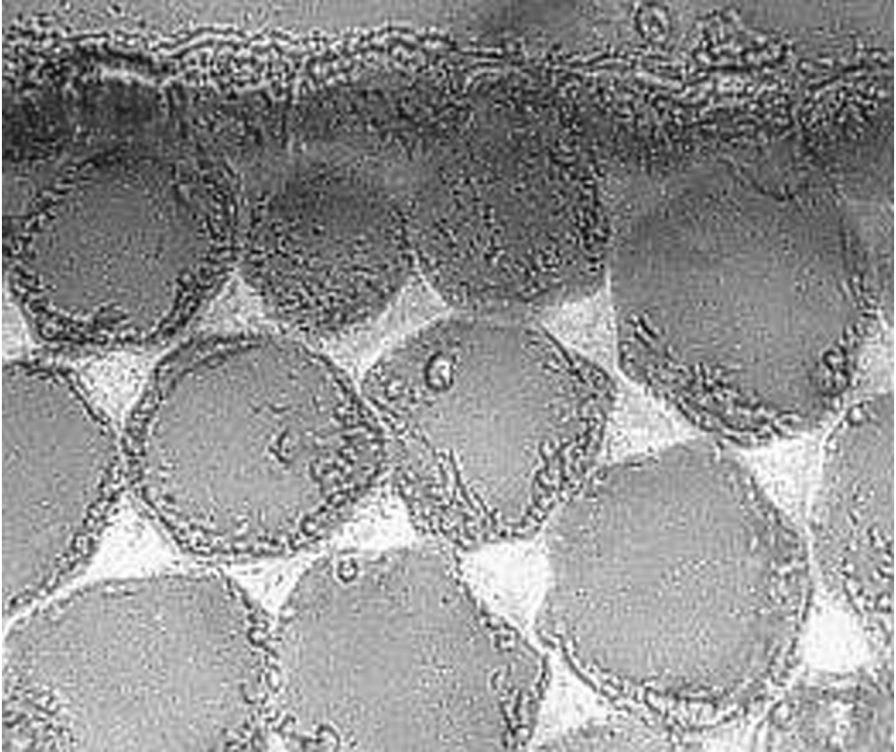


Figure 37. Collenchyma. Note the many connections and pits in the cell walls and the typical gluey exudate in this fresh slice through collenchyma tissue.

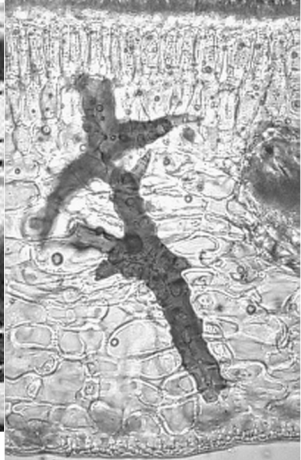
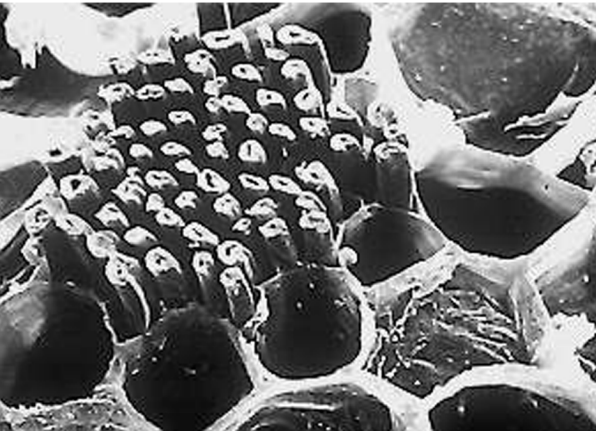


Figure 38. Sclerenchyma. Fibers (left) are bundled together to form a string-like reinforcing structure in the center of a field of parenchyma tissue. Sclerids (left) are irregular and small in shape, again embedded in a field of parenchymal tissue.

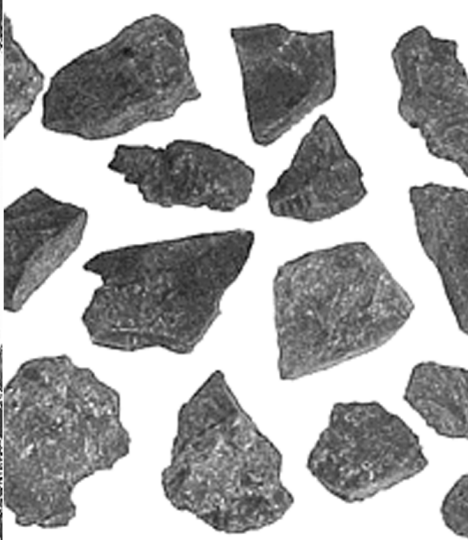


Figure 39. Cutin waxes: carnauba wax. Palms of the genus *Copernicia* (left) are the commercial source of carnauba wax. The leaves accumulate heavy layers of wax secreted to form the cuticle. They are harvested, dried, and then beaten to break off the raw carnauba wax (right).

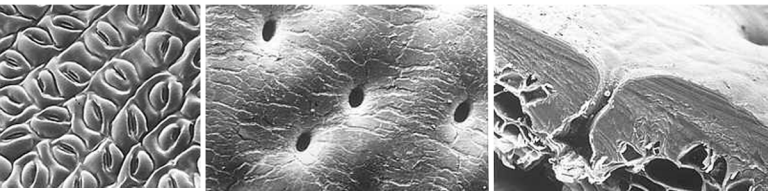


Figure 40. Stomata. Electron micrographs illustrate the central stomata with surrounding guard cells in a larger field of epidermal cells (top, stomata occur in pairs). Many stomata are present in tropical ferns (lower left) as an adaptation to a humid environment. Cactus (lower center, right) from a xeric environment have sparse, deeply inset stomata and a thick cuticle layer.

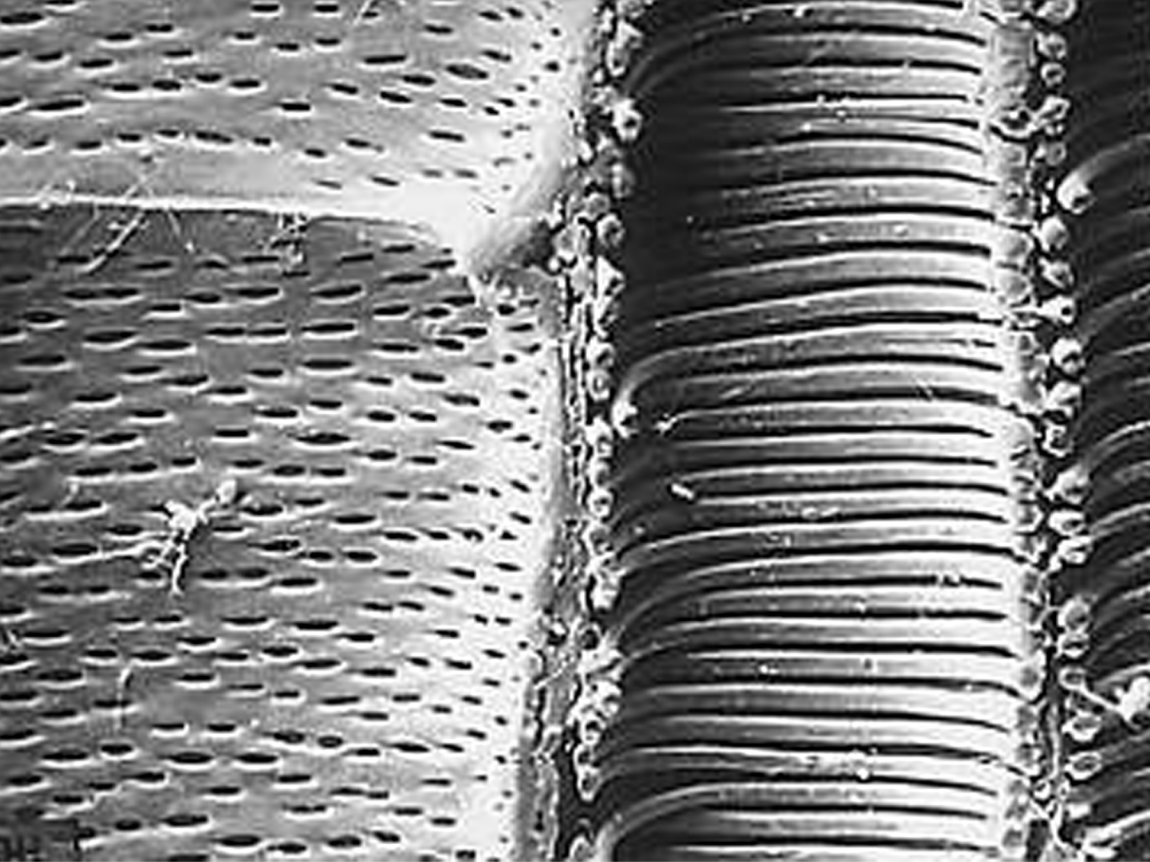


Figure 42. Longitudinal Section Through Part of a Pumpkin's (*Cucurbita pepo*) Xylem. This electron micrograph shows different vessel elements. At the right side of the picture primary xylem (tracheary elements with helical thickenings) can be seen. To the left is secondary xylem (tracheary element with pitted walls). Note these are both tracheid elements because the cells are short with closed but pitted end cell walls. Vessels are similar in appearance but lack end cell walls.

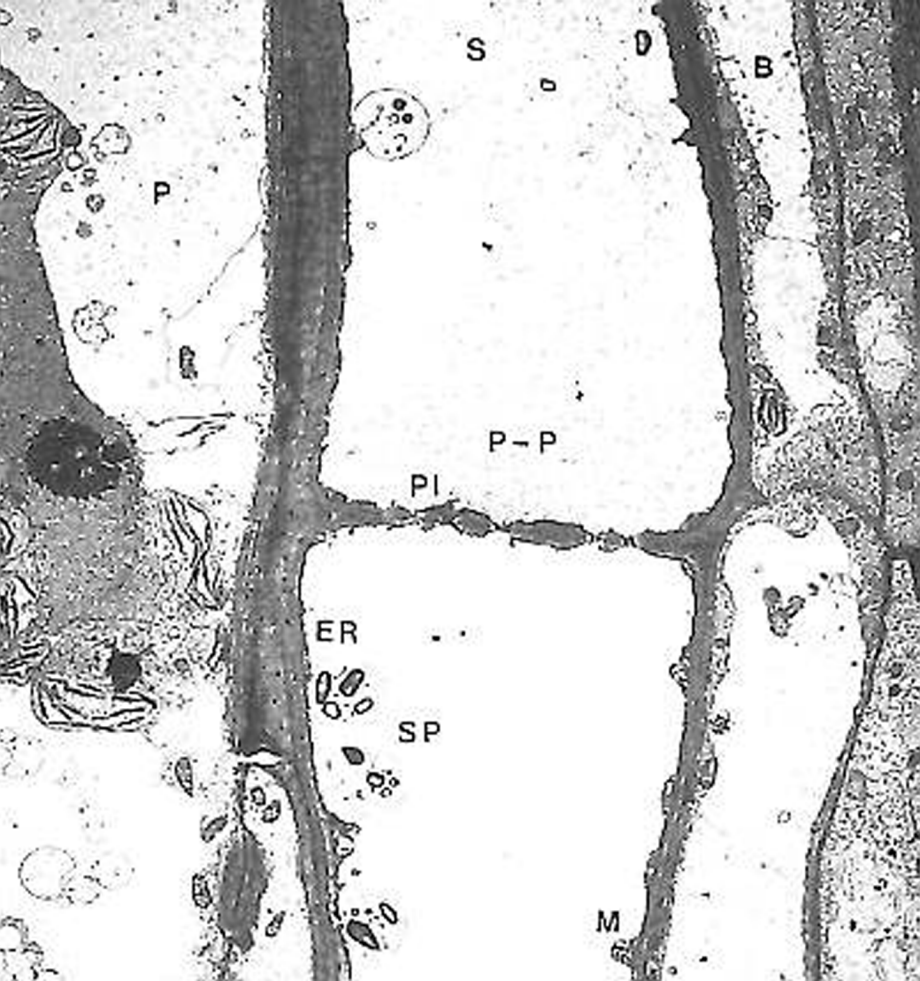


Figure 43. Longitudinal Section Through the Phloem of *Cheiranthus cheiri* (Brassicaceae). This electron micrograph shows a sieve tube without (S) and companion cells with nuclei (B). They are bordered by a parenchyma cell (P). The sieve tube contains sieve tube plastids (SP of the S-Type), mitochondria (M), endoplasmic reticulum (ER) and P-proteins (P-P). The sieve plate (P1) is perforated by pores.