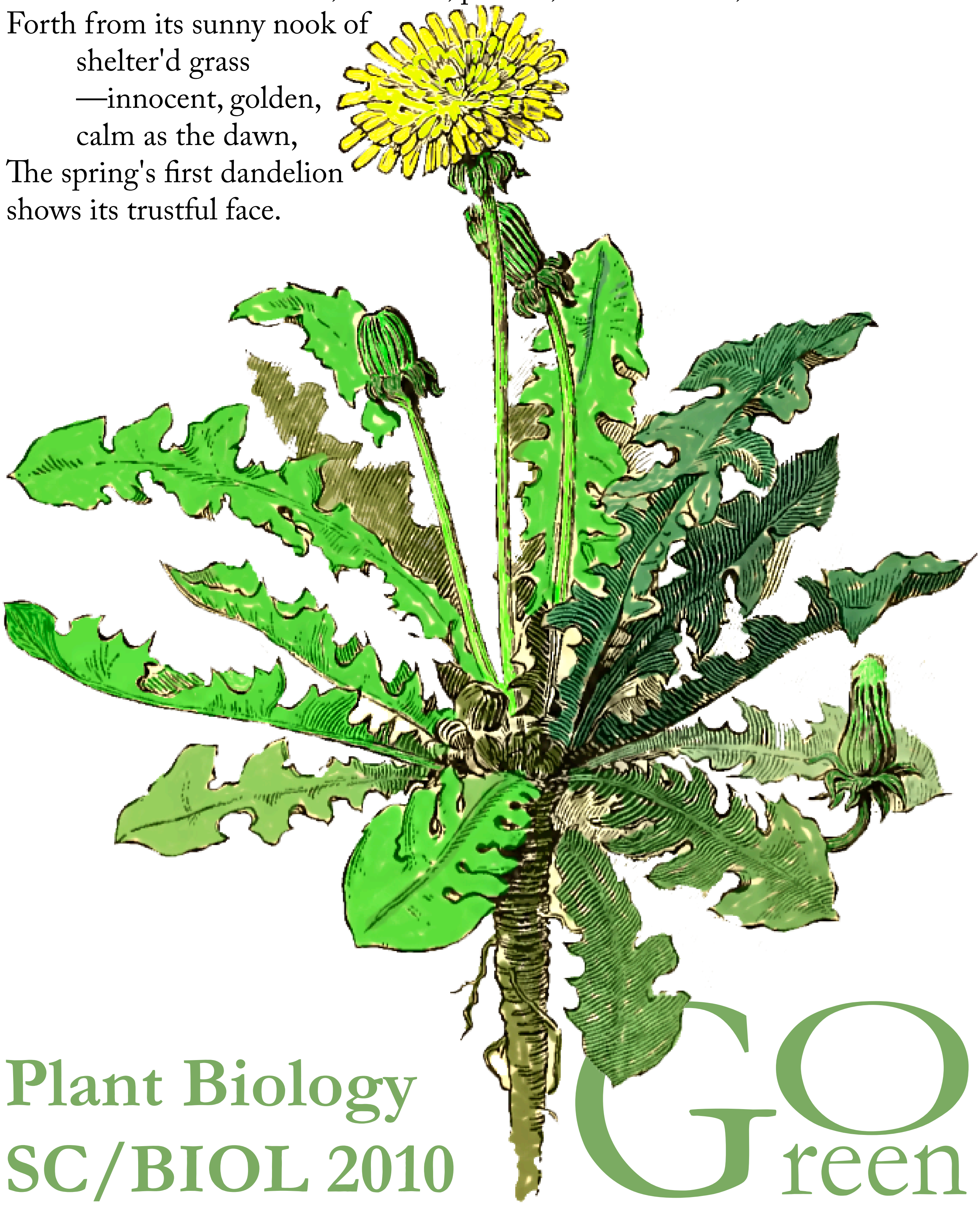
The First Dandelion (Walt Whitman "Leaves of Grass")

Simple and fresh and fair from winter's close emerging,
As if no artifice of fashion, business, politics, had ever been,
Forth from its sunny nook of
        shelter'd grass
        —innocent, golden,
        calm as the dawn,
The spring's first dandelion
shows its trustful face.



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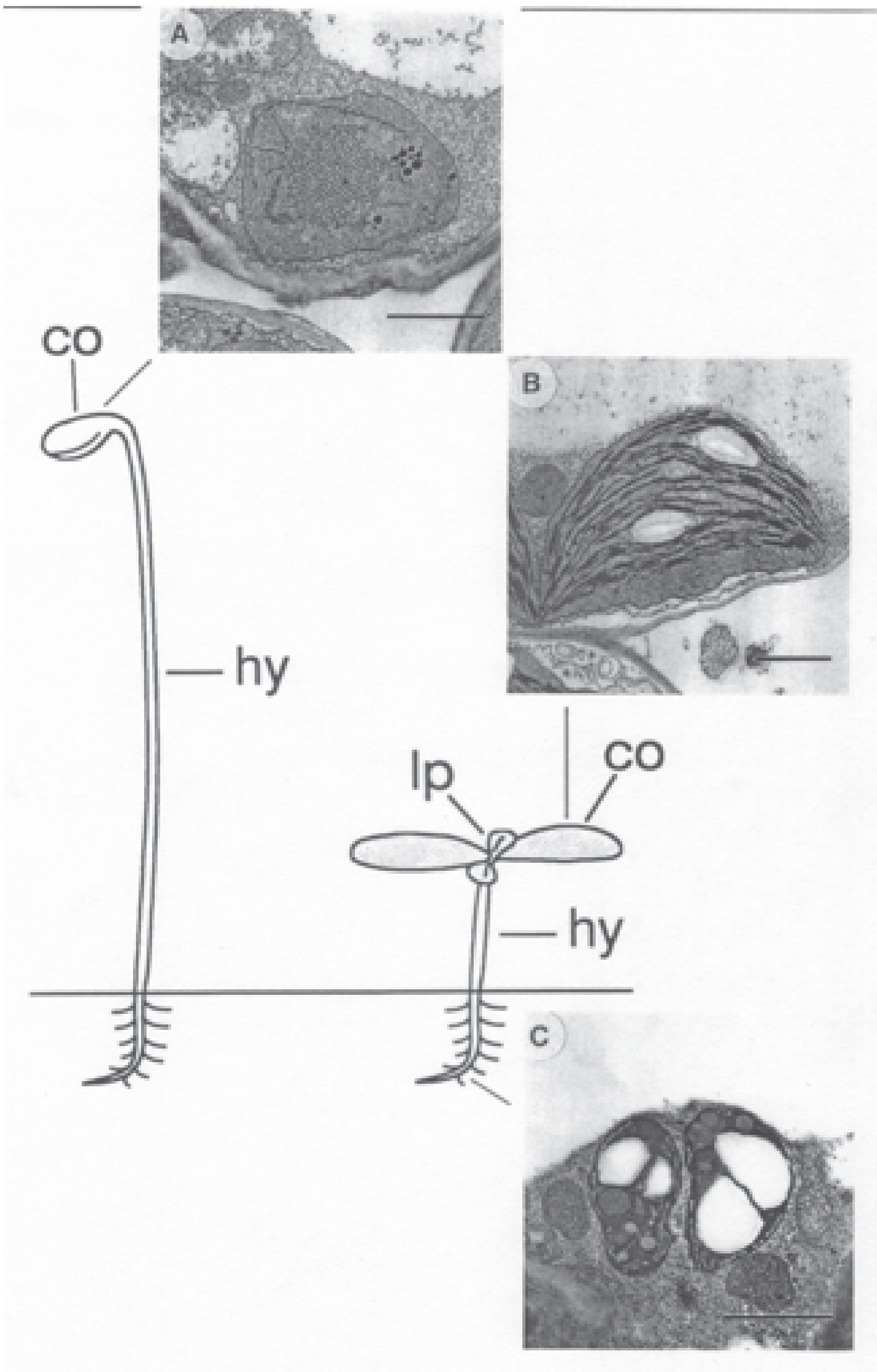

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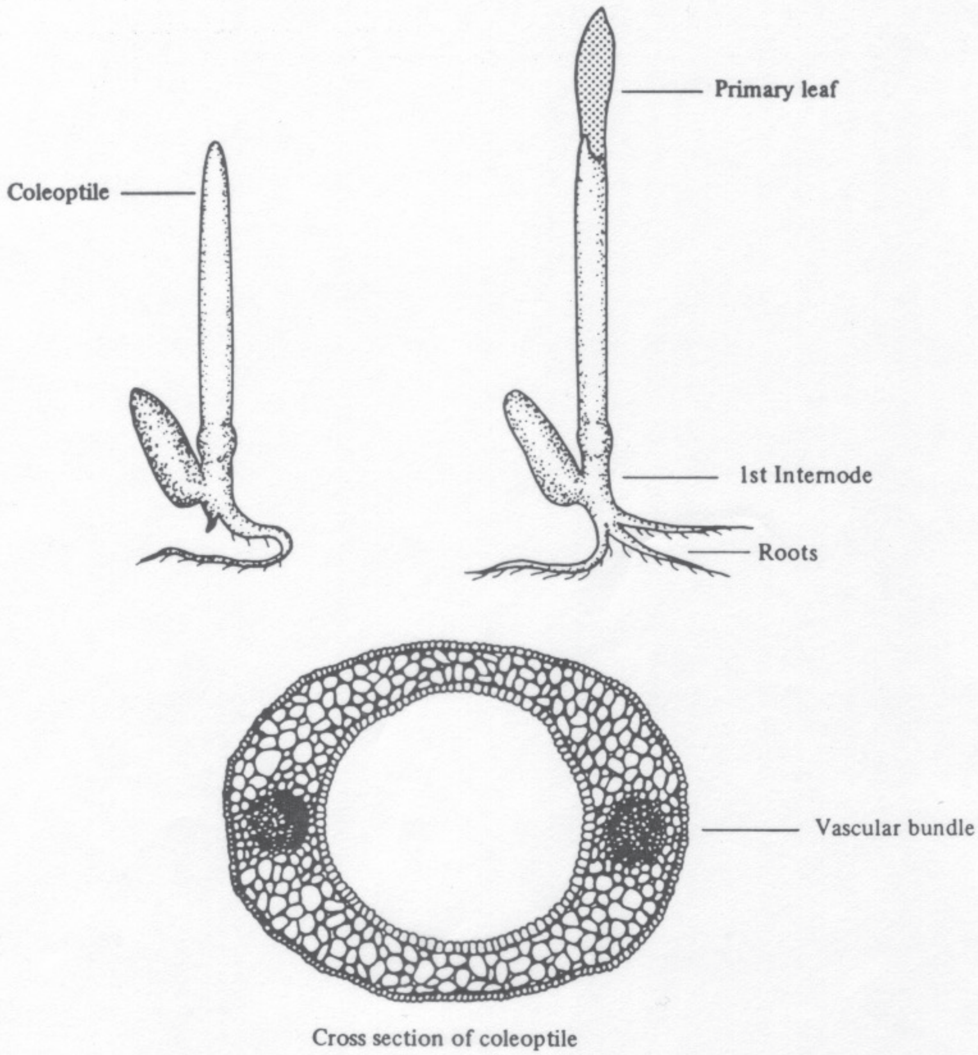

FIGURE 2.1. The *Avena* coleoptile. The coleoptile is a hollow cylinder enclosing the epicotyl and is attached to the axis of the seedling at the first node. It is a leaf-like structure and the first part of the plant to emerge from the soil. Coleoptiles are characteristic of the grasses. The first leaf, as it expands, eventually pierces the coleoptile at its apex after which growth of the coleoptile ceases. Cell division takes place in an etiolated *Avena* coleoptile until it reaches about 1 cm in length, after which cell division ceases and it elongates for 4 days at a rate of approximately 1 mm/hour. (Redrawn, with permission, from Bonner and Galston, 1952.)

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Thomas C. Moore

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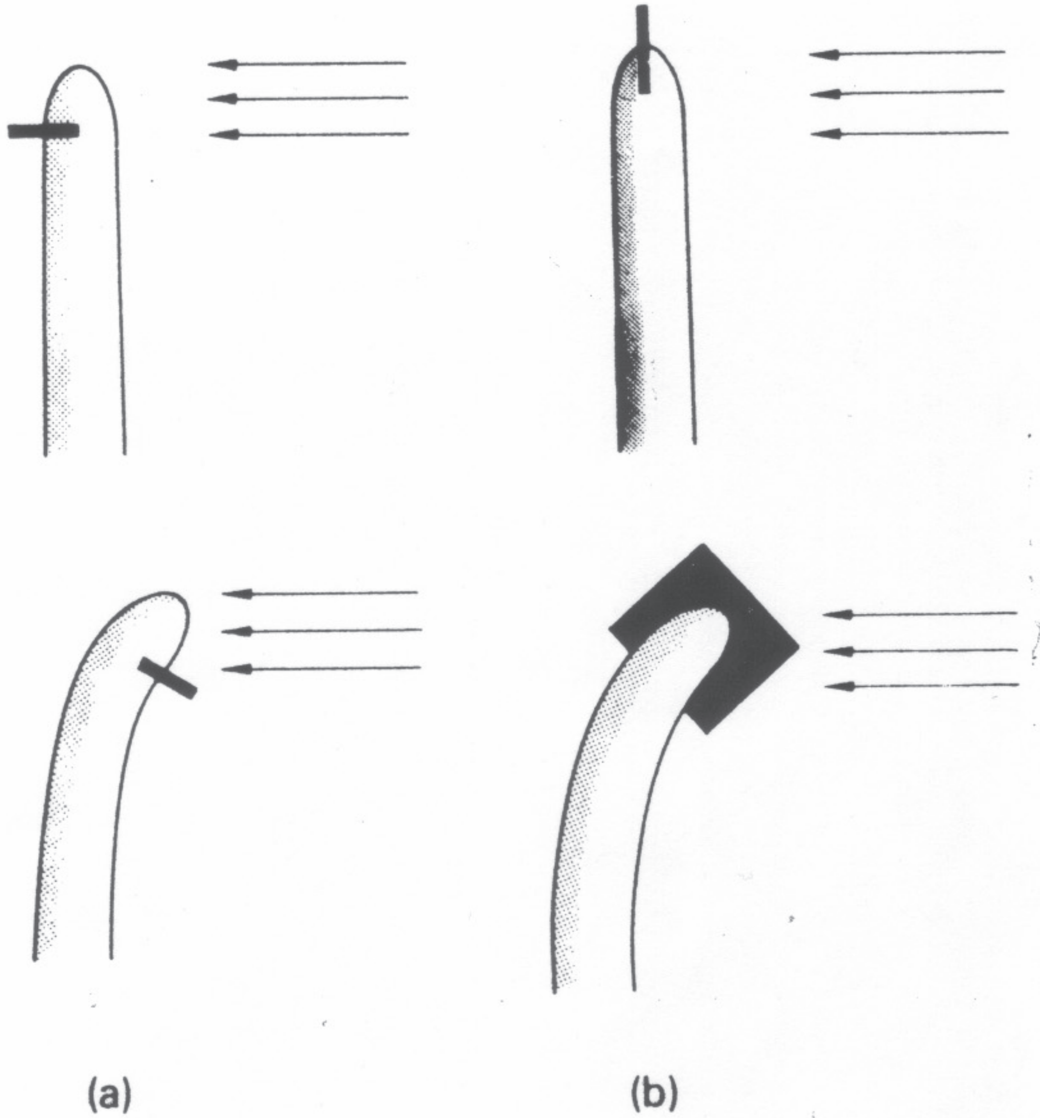


Fig. 7.7. Two experiments performed by Boysen-Jensen in 1928, which indicated that auxin moves preferentially down the shaded half of a unilaterally illuminated coleoptile (a), and that this involves lateral transport of auxin from the illuminated to the shaded side (b). Only when the route of basipetal auxin movement in the darkened side was unimpeded did a growth curvature appear (a). Similarly, a mica sheet inserted vertically into the tip region at right angles to incident light prevented a phototropic response, presumaby because auxin could not migrate laterally. A similar mica sheet inserted parallel to the light rays did not prevent curvature (b).

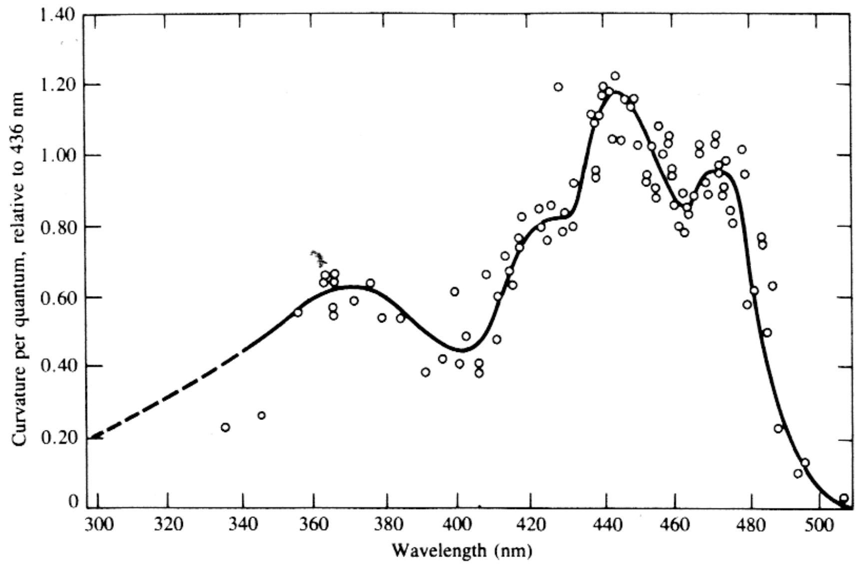


FIGURE 8.10. Action spectrum for the first-positive phototropic curvature of *Avena* coleoptiles, a non-phytochrome-mediated photoresponse to blue light. (Redrawn, with permission, from Curry, 1969.)

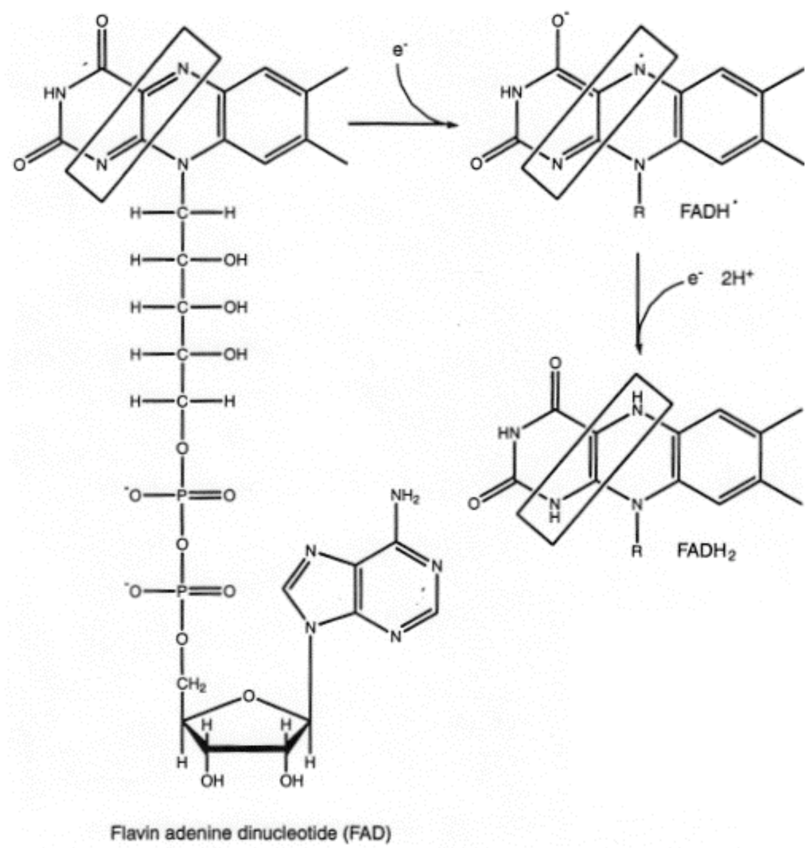


Figure 7.12 Structure of flavin adenine dinucleotide (FAD), the cofactor for ferredoxin-NADP reductase. The oxidized quinone (FAD), partially reduced semiquinone (FADH˙) and fully reduced hydroquinone ($FADH_2$) forms are shown. The redox-active portion of the isoalloxazine ring is boxed.

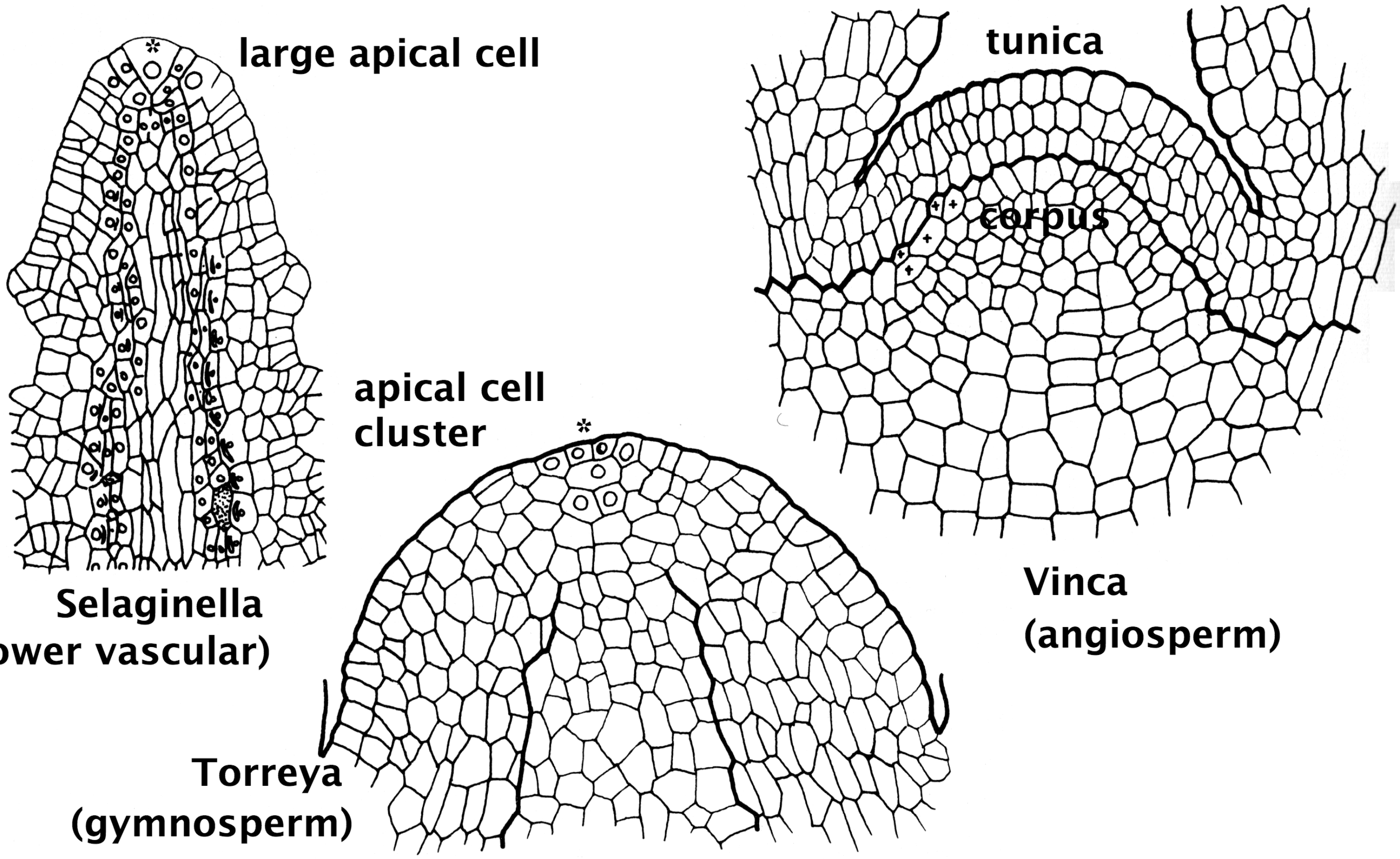
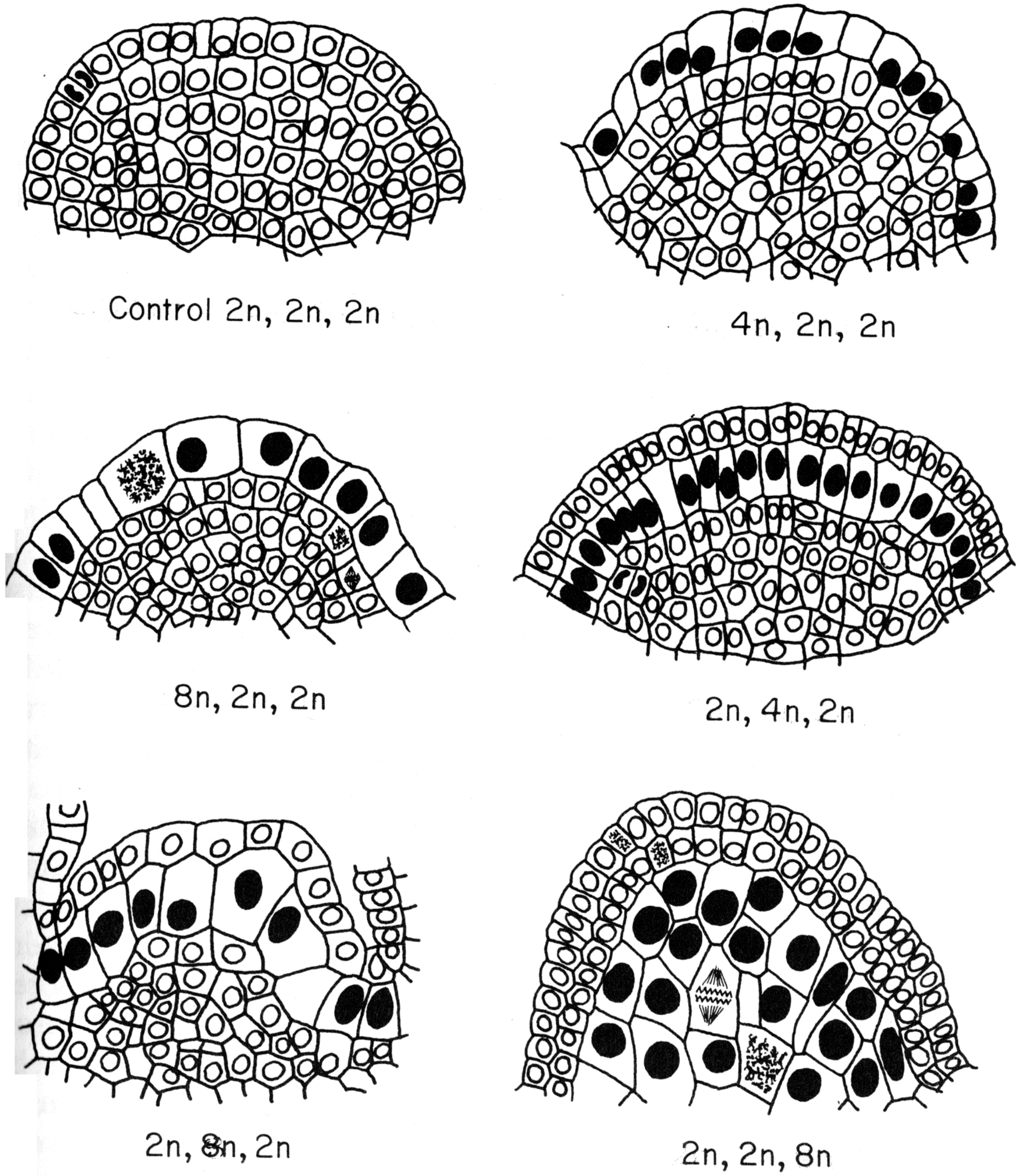


Figure 16-2. Longitudinal sections of three different types of shoot apex. **Left:** *Selaginella wildenovii,* showing the large apical cell characteristic of lower vascular plants. **Center:** *Torreya californica,* a gymnosperm, showing the cluster of apical initials and an almost complete lack of layering. **Right:** *Vinca minor,* an angiosperm, showing the three-layered tunica and below it the unlayered corpus. [Left to right: After B. D. Barclay, *Bot. Gaz.,* **91:**452 (1931); M. A. Johnson, *Phytomorphology,* **1:**188 (1951); A. Schmidt, *Bot. Arch.,* **8:**345 (1924)]



Drawings of periclinal chimeras of *Datura*. Shoots were treated with colchicines to induce polyploidy in various layers. Polyploidal cells are recognized by larger nuclei (and larger cell size). Polyploidal cells occupied one of the three organized layers of the tunica corpus (Li, L2, or L3). Scanned from Steeves and Sussex 1989 Patterns in Plant Development. Cambridge University Press.

Spatial orientation is described by phyllotaxy

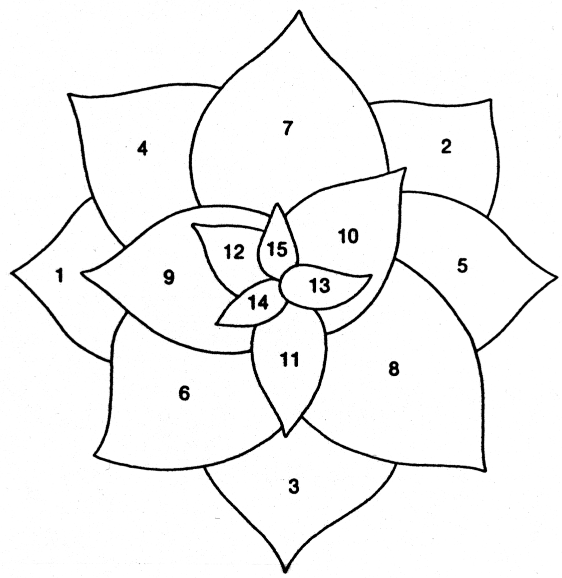


Figure 17-8. Diagram of a shoot with 3/8 phyllotaxy viewed from above. Note that every eighth leaf is directly above another leaf (for example leaf 9 is over leaf 1 and 10 over 2) and that three turns around the stem are required to reach the eighth leaf. [After E. W. Sinnott and K. S. Wilson, *Botany: Principles and Problems,* 6th ed., McGraw-Hill Book Company, New York, 1963]

As noted above, phyllotaxy is usually expressed as a fraction

The denominator is the number of leaves between two leaves directly above eachother (e.g. 1 & 9 in the diagram above)(an orthostichy) The numerator is the number of turns around the stem in the orthostichy.

Phyllotaxy is remarkably consistent for any given plant species, though some species do shift from a juvenile phyllotaxy to a mature one.

In leaf development, except for the very young primordia, there is no specific meristematic region.

If cells are mutated just prior to the initiation of lamina growth, one sees three clonal sectors: a) those extending from the mid-rib partway into the lamina; b) those limited to the leaf margin; and c) those isolated from both midrib and leaf margin. This is consistent with a 'generalized' meristematic activity throughout the developing lamina.

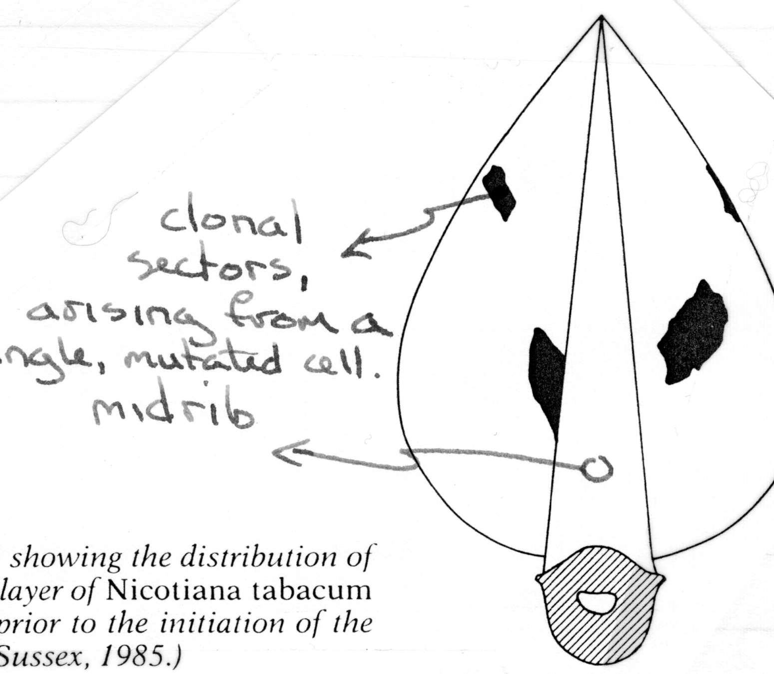


Figure 9.3. *Diagram showing the distribution of clones in the palisade layer of* Nicotiana tabacum *leaves irradiated just prior to the initiation of the lamina. (Poethig and Sussex, 1985.)*

Nicotiana tabacum will be used as an example of angiosperm / dicotyledon. leaf development:

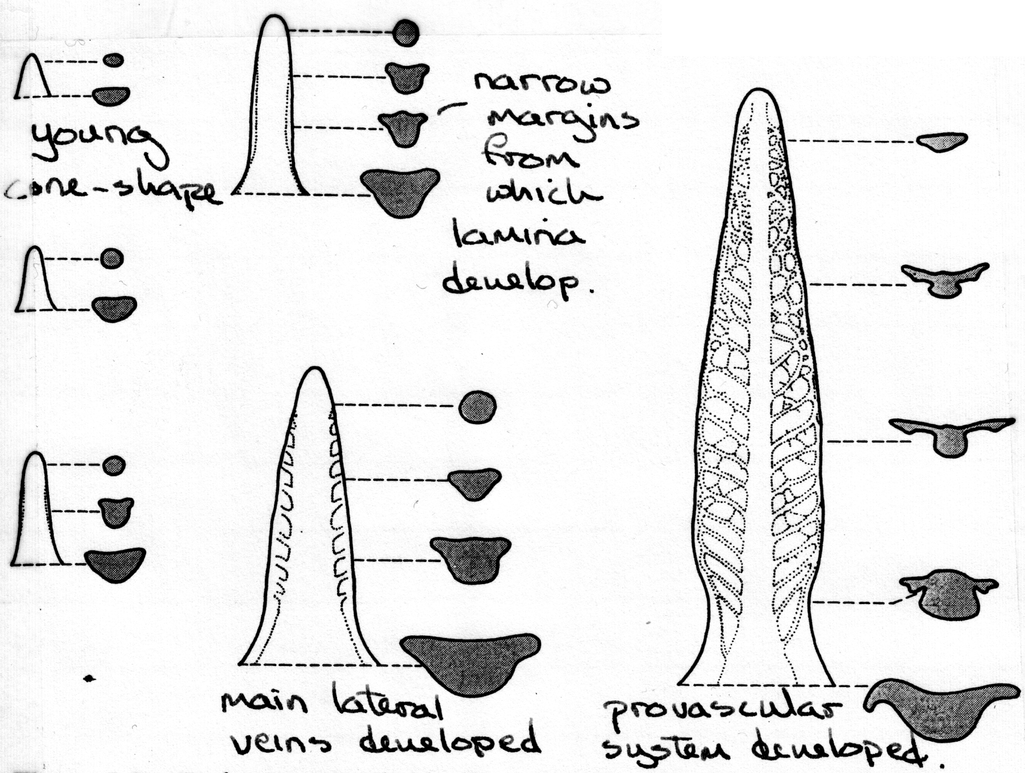


Figure 9.2. *Early stages in the development of a vegetative leaf of* Nicotiana tabacum. *At each stage the leaf is shown in face view on the left and in transverse section at several levels. The primordium first develops as a small peglike outgrowth widest at the base. Development of the blade begins later, and because blade development is more intensive above the base, the outline of the leaf becomes ovate in face view. (G. S. Avery,* Am. J. Botany *20:565, 1933.)*

Note that the developing shape results from selective cell division (anticlinal and periclinal). At first, the primordia elongates and then margins appear, from which arises the lamina (leaf blade). Then, differentiation into protophloem, protoxylem etc. cells results in formation of the pro vascular system.

In monocotyledons, the development of the leaf follows a very different pattern.

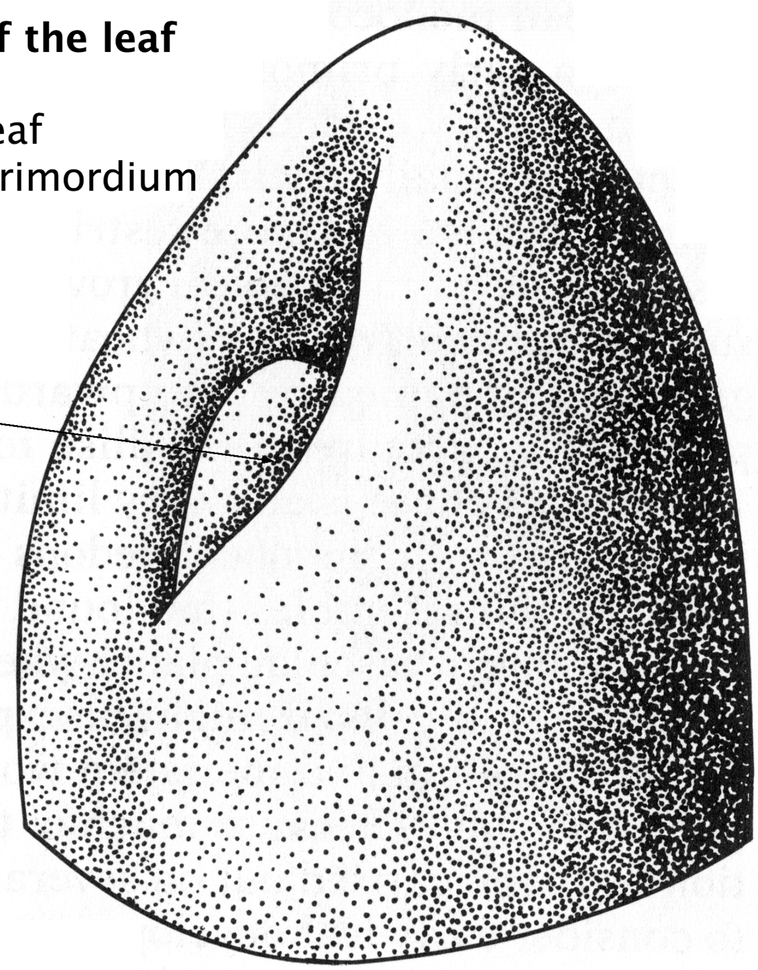
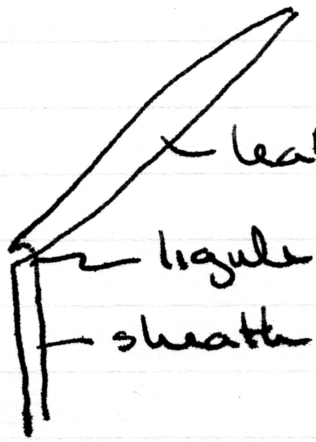


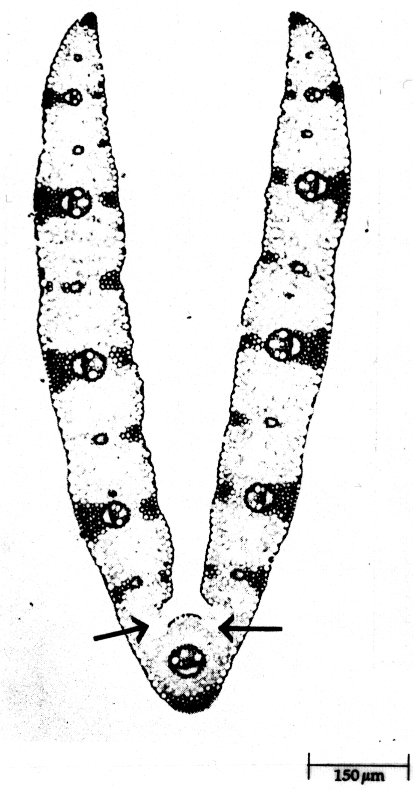
Figure 7.3. *Three-dimensional representation of the shoot tip of* Triticum *showing the hooded form and encircling base of a leaf primordium. The next younger primordium is just becoming visible. ×185. (Redrawn from Williams, 1975.)*

In the grasses, the form of the leaf is quite different



As is the pattern of cell division and cellular expansion.

21-21
Transverse section of annual blue grass *(Poa annua) leaf. In the grass leaf, the* ***mesophyll*** *is not differentiated as pali-* ***sade*** *and spongy parenchyma. Notice the* ***sclerenchyma*** *cells (the dark cells bordering the veins and extending to the epidermis). The epidermis of the grass* ***leaf*** *contains bulliform cells, which are larger than the other epidermal cells. The bulliform cells are thought to play a part in the rolling or unrolling, folding or unfolding of grass leaves. In the Poa leaf shown here, the bulliform cells (arrows) are partly collapsed and the leaf is folded. An increase in turgor in the bulliform cells would presumably cause the leaf to unfold, although studies indicate that other tissues are also involved in this phenomenon.*



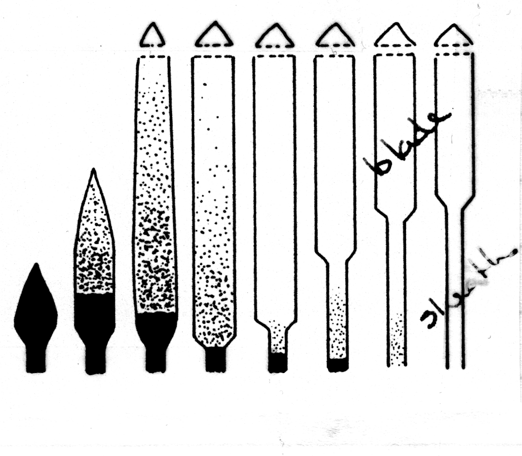


Figure 9.7. *Leaf expansion in* Zea mays *showing intercalary growth in both blade and sheath. Cell division is occurring in regions shown in solid black. Stippled zones are regions of cell expansion. (Adapted from B. C. Sharman,* Ann. Botany *6:245, 1942.)*

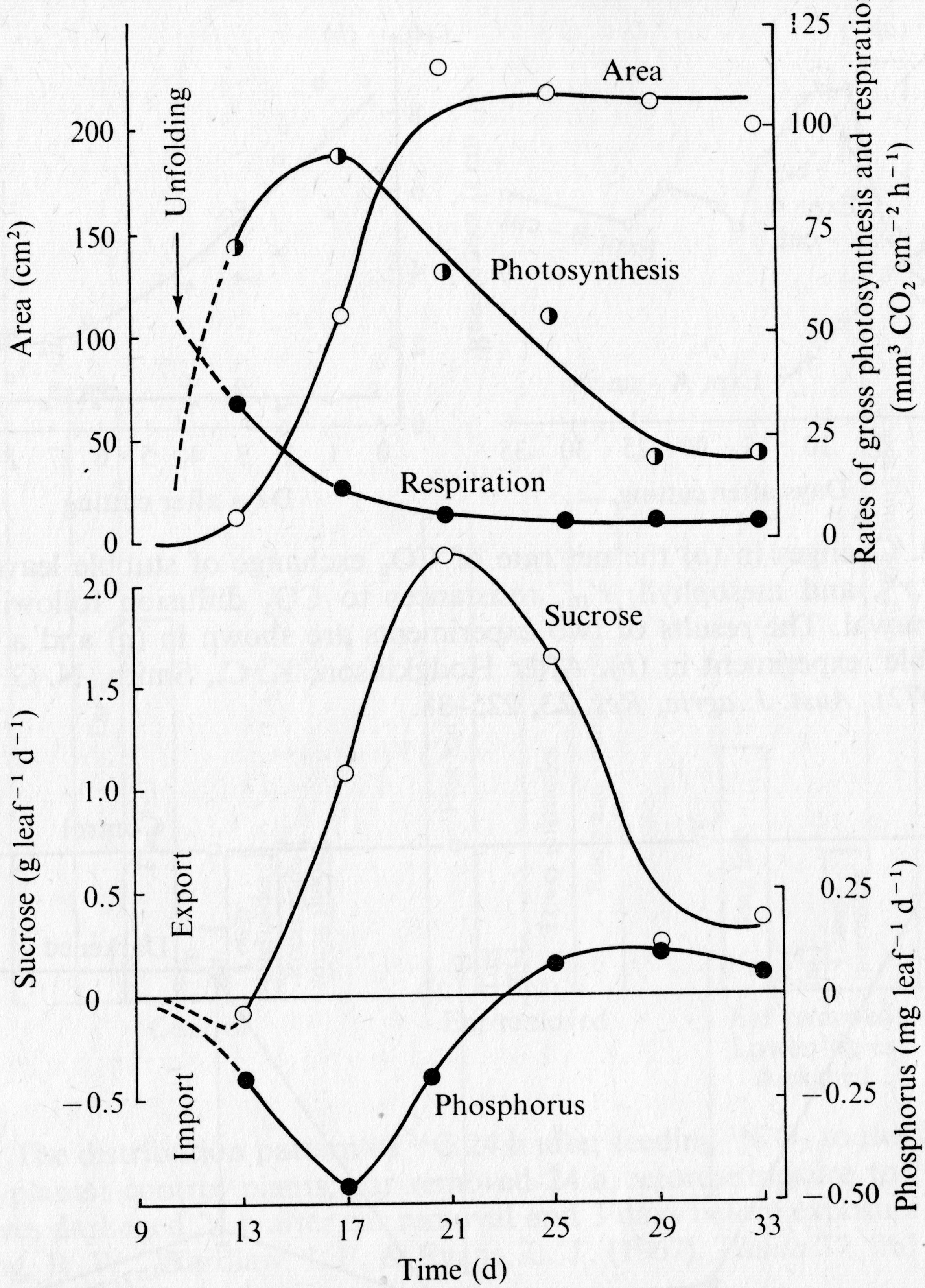


Fig. 5.18. The change in leaf area, L, rates of photosynthesis, P_s, and respiration, R, and import and export of sucrose, S, and phosphorus, P, during the ontogeny of the second leaf of cucumber. After Hopkinson, J. M. (1964). *J. exp. Bot.* **15**, 125–37.

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Fig. 75.1 Distribution of the cultivated coffees, *Coffea arabica* and *C. canephora*.

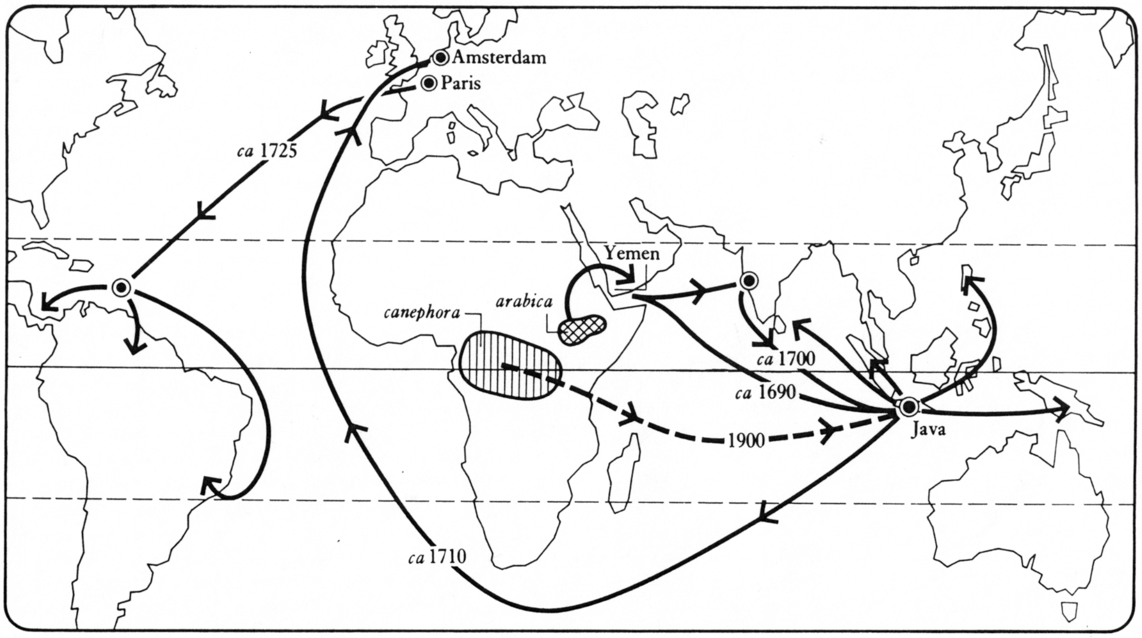
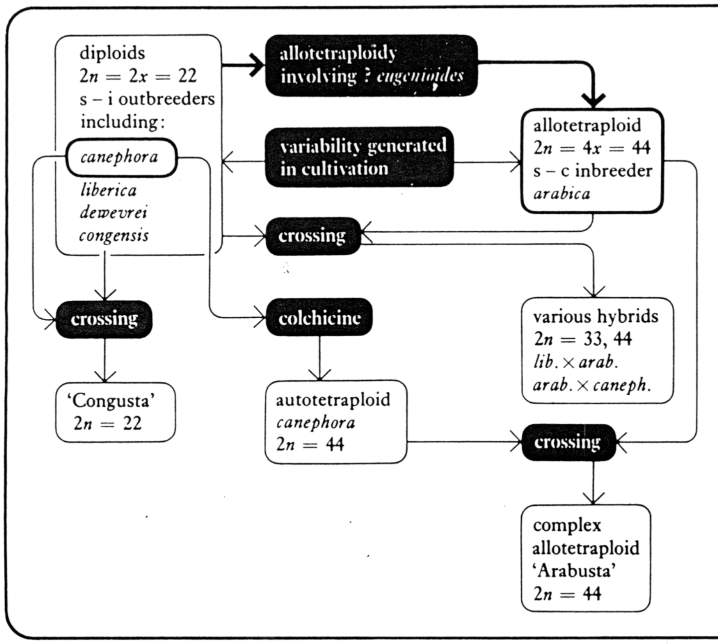


Fig. 75.2 Relationships of the cultivated coffees, *Coffea*.



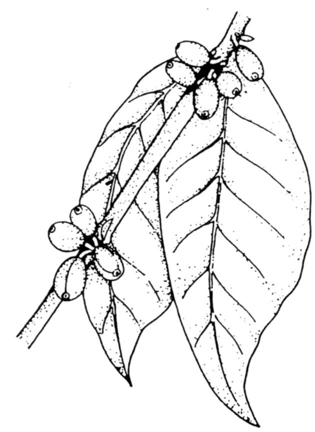
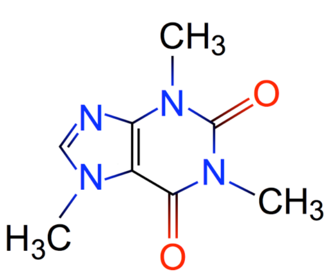


Figure 4.30 Fruiting branch of coffee *(Coffea arabica).*

Source: Ferwerda FP (1976) Coffees. *Coffea* spp. (Rubiacese) In Simmonds NW (ed.) Evolution of Crop Plants. Longman. pp. 257–260.



Caffeine structure