CHAPTER FOUR

Shape, growth directions, and surface structure

4.1 MAINTENANCE OF SHAPE

The formation of leaves, the outgrowth of axillary buds, and the formation of lateral roots all involve the formation of a new growth axis at right angles, or normal, to the previous axis. We need to understand: (1) how the growth direction of the original axis is maintained; and (2) how a new axis is formed, i.e. how is the new direction of growth initiated and maintained? We also need to know the relative contributions of changes in the rates and orientations of growth to the growth process (Box 4.1).

The dome-like shape of the typical shoot apex and the tunica–corpus

Box 4.1 The basis of changes in shape

Changes in the shape of organs and plant parts can occur in more than one way. For instance, a cylinder growing to a trumpet shape could do so in basically two ways. In the first, growth is isotropic (equal in all directions) but there is a gradient of increasing growth rate from left to right (Fig. 4.1a). In the second, the growth rate is the same throughout but growth is anisotropic (an- = not), being increasingly circumferential (transverse) toward the right-hand end and increasingly longitudinal toward the left (Fig. 4.1b). Similarly, leaf initiation can involve mainly a local increase in growth rate to form a bulge (e.g. Silene), or mainly changes in growth direction (e.g. Pisum) (see section 4.3).

In tip growth of fungal hyphae, root hairs, and moss and fern protone-mata, the bending of the filament can be either by differential growth rates just behind the tip, i.e. bowing (Fig. 4.1c), or by bulging, i.e. essentially the establishment of a new tip to one side of the old one, analogous to branching but where the original axis ceases growth (Fig. 4.1d).

The mechanism by which shape changes often cannot be inferred easily. Only direct measurements of markers on the surface can show what the bases for change of shape are in any particular growing structure.

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Figure 4.1 Different ways of achieving the same changes in shape. A cylinder growing to a trumpet shape could grow either (a) isotropically but with increasing area growth rate from left to right or (b) anisotropically, with the same area growth rate throughout but with a decreasing longitudinal (l) and an increasing transverse (t) component from left to right. Bending in tip growth could be either (c) by bowing, the growing point remaining at the tip but differential growth behind the tip, or (d) by bulging, where a new growing point takes over and directs growth downward. (After Green et al. 1970).