...going one step further

T21001

English

Model of Helleborus niger (Christmas rose) leaf

The model of a Helleborus niger leaf shows a cube-shaped detail of the pedate, bifacial (2-sided) deciduous leaf.

The green leaves of the plant are stem axis appendages. The green colour is due to the presence of a large number of green (chlorophyll-containing) chloroplasts (10), which are the cell organelles responsible for carrying out the process of photosynthesis in photoautotrophic plants (plants that derive their energy from sunlight by photosynthesis). The leaf is 2-sided in the sense that the upper and lower epidermis differ from each other, with stomata (tiny pore-like openings) only found in the lower epidermis.

The upper epidermis (1) is the adaxial side, i.e. the side of the leaf (blade, lamina) facing toward the axis. The surface is oriented to the sunlight. The cells of the upper epidermis are immediately adjacent to each other, have the same structure and do not contain any chloroplasts, but have a thickened outer wall, covered by a thin layer of folded amorphous cutin, the cuticula. The lower abaxial epidermis (2) generally has the same structure except for the additional stomata (11) found there. The stomatal complexes are basically made up of a pair of bean-shaped, mobile guard cells (9), covered by an unevenly thick cuticula, with the cuticula reaching all the way into the substomatal cavity (8). An opening (or gap) between the guard cells is created when the turgor (pressure inside the cell) is high, i.e. the presence of sufficient water and ions in the cytoplasm (inside the cell), making it possible for the gas exchange process necessary for photosynthesis to take place with the surrounding environment. These two guard cells are the only cells of the epidermis that contain chloroplasts, since the photosynthetic energy obtained with the help of the chloroplasts is used for opening and closing the guard cells.

Located between the upper (1) and lower (2) epidermis, is the mesophyll (3-4), composed of an upper chloroplast-rich layer of palisade parenchyma (3) and a layer of spongy parenchyma (4) beneath. The mesophyll is also called assimilation tissue, since the chloroplasts contained in the cells are capable of producing sugar and oxygen from water and CO_2 (carbon dioxide) with the help of sunlight, by the process of photosynthesis, thereby assimilating the light. The number of chloroplasts close to the walls in the palisade layer facing the light is higher than in the spongy layer. The spongy layer however contains large spaces between individual cells filled with gas and water vapour, so-called intercellular spaces (8a), which are all interconnected to the largest intercellular space, the substomatal cavity (8). The exchange of gases from the inside of the leaf (mainly oxygen) with exterior gases (mainly CO_2) for maintaining metabolic processes, mainly occurs via the guard cells of the stomatal complexes, under the outer cuticular striations of which the smaller atrium (8b) and the large substomatal cavity (8) are located.

The leaf veins are slightly indented in the upper leaf, while slightly protruding in the lower leaf, forming a network of branching out vascular bundles, with the main vein (midrib) shown in the model (5-7). The water-conducting xylem (6) is always located on top, supplying all the parts of the leaf with water and ions absorbed through the roots. This water reaches all sections of the leaf via dead cells, large vessels, the walls of which are covered with lignified (turned to wood) e.g. net-shaped deposits and smaller tracheids, the walls of which are often thickened with spiral-shaped lignified material. Under the xylem, lies the phloem (7), which is the nutrient-conducting part of the vascular bundle, supplying all nutrient-storing parts of the plant with a solution of the high-energy sugar obtained from photosynthesis in the chloroplasts. The phloem is made of large dead sieve tube elements and a small companion cell accompanying each sieve tube element, both of which originating from an unequal division of one mother cell.

The living companion cell is responsible for control of the transport processes. Xylem and phloem are generally surrounded by a unicellular layer, the sclerenchymatous vascular bundle sheath (5). Sclerenchyma is made of dead cells with thickened cell walls, which facilitates its function as a supporting tissue. Thin-walled, living conducting cells are scattered in this sclerenchyma casing. The bifacial deciduous Helleborus niger leaf represents the most common leaf type in the plant kingdom.

1	Upper epidermis with cuticula
2	Lower epidermis with stomata
3 - 4	Mesophyll = assimilation tissue
3	Palisade parenchyma
4	Spongy parenchyma
5 - 7	Ascular bundle
5	Sclerenchymatous vascular bundle sheath
6	Xylem
7	Phloem
8	Substomatal cavity
8a	Intercellular space
8b	Atrium
9	Guard cell
10	Chloroplast
11	Stoma, pore


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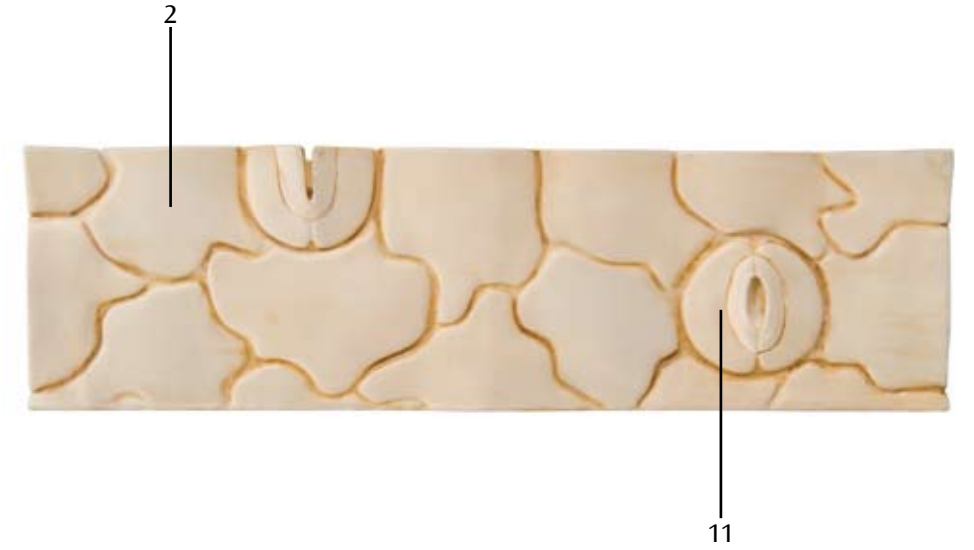
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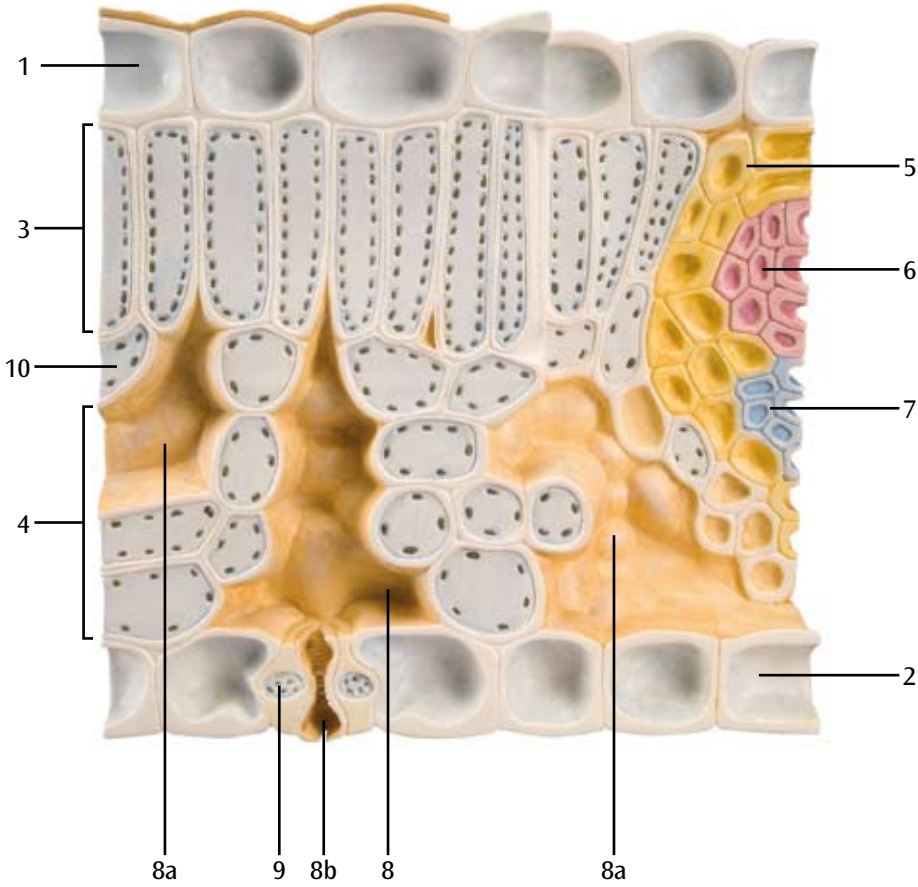
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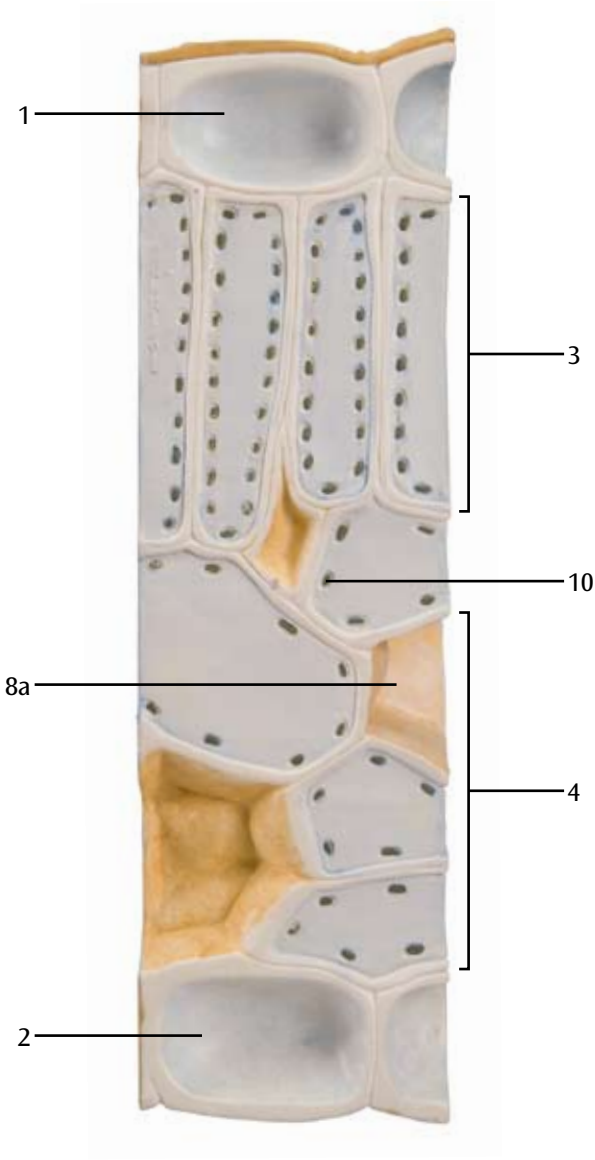
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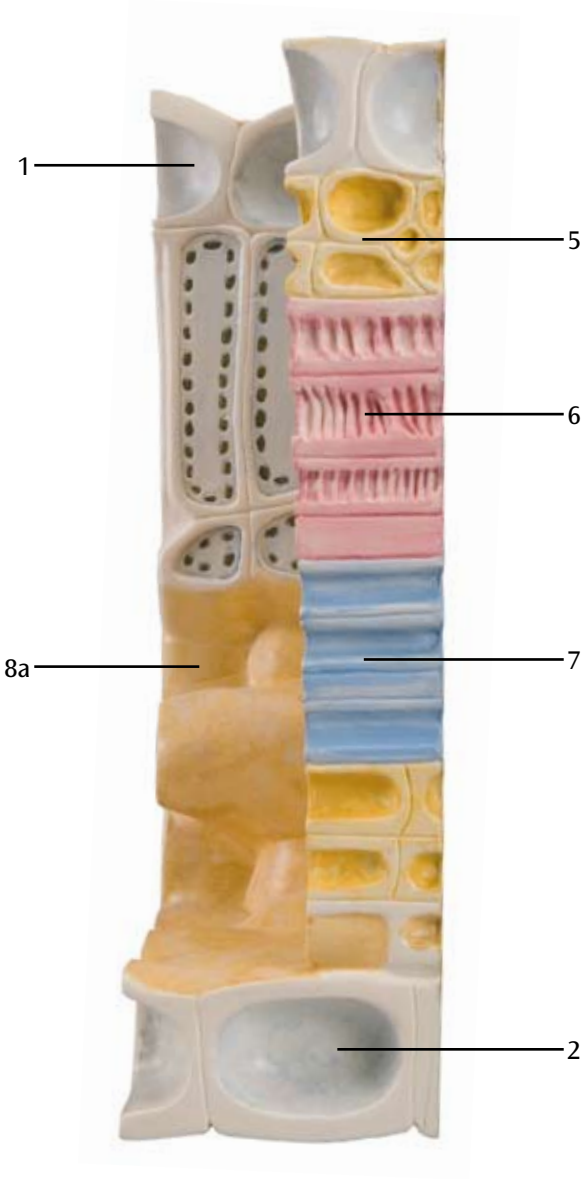
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