Functional Characteristics and Features of Stoma

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Perspective

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ABOUT THE STUDY

In botany, a pore located in the epidermis of leaves, stems, and other organs is known as a stoma. It regulates the rate of gas exchange. A pair of specialized parenchyma cells called guard cells surrounds the pore, controlling the size of the stomatal opening.

The term is frequently used to refer to the complete stomatal complex, which includes the paired guard cells and the pore also known as the stomatal aperture. By gaseous diffusion, air that contains both oxygen for respiration and carbon dioxide for photosynthesis travels through stomata. Transpiration is the mechanism through which water vapour diffuses into the atmosphere through the stomata.

Carbon dioxide intake and water loss

Carbon dioxide, a key reactant in photosynthesis, is present in the atmosphere at a concentration of about 400 ppm. Most plants require the stomata to be open during daytime. Water vapour fills the air gaps in the leaf and escapes through the stomata, a process known as transpiration. Because of this, plants cannot absorb carbon dioxide without simultaneously losing water vapour.

Alternative approaches

In mesophyll cells that are immediately exposed to the air gaps inside the leaf, the enzyme RuBisCO normally fixes carbon dioxide to Ribulose 1, 5-Bisphosphate (RuBP). Due to two factors first, RuBisCo's low affinity for carbon dioxide and, second, the fact that it fixes oxygen to RuBP the transpiration issue is made worse. This results in photorespiration, a wasteful process that uses both energy and carbon. RuBisCo requires high carbon dioxide concentrations for both of these reasons, which calls for broad stomatal apertures and considerable water loss as a result.

Phosphoenolpyruvate carboxylase, an intermediary molecule with a high carbon dioxide affinity, can be employed in conjunction with smaller stomatal apertures (PEP case). However, recovering the carbon fixation products from PEP case requires a lot of energy. Because of this, the PEP case option is only preferable in situations where water is scarce but light is abundant or where high temperatures make oxygen more soluble relative to carbon dioxide, which exacerbates RuBisCo's oxygenation issue.

CAM plants

After the family *Crassulaceae*, which includes the species in which the CAM (Crassulacean Acid Metabolism) process was first discovered, a group of mostly desert plants known as "CAM" plants (Crassulacean Acid Metabolism) open their stomata at night (when water evaporates from leaves more slowly for a given degree of stomatal opening), use PEP carboxylase to fix carbon dioxide, and store the products in large vacuoles. The carbon dioxide fixed the previous night is released into the presence of RuBisCO when they close their stomata the following day. RuBisCO is saturated with carbon dioxide as a result, allowing for minimal photorespiration. This strategy is only preferable when water is extremely scarce because of the capacity of the vacuoles to store fixed carbon.

Opening and closing of stomata

Since most plants lack CAM, they must constantly open and close their stomata throughout the day in response to shifting environmental factors including humidity, carbon dioxide concentration, and light intensity. A proton pump pulls protons (H+) out of the guard cells when the environment is favorable for stomatal opening (for example, high light intensity and high humidity). Thus, the electrical potential of the cells shifts from positive to negative. Potassium ions (K+) are taken up when the voltage-gated potassium channels are opened by the negative potential. Negative ions balance the potassium inflow to maintain this internal negative voltage and prevent the input of potassium ions from ceasing. In some instances, chloride ions enter, whereas in other plants, guard cells create the organic ion malate. Osmosis causes water to diffuse into the cell as a result of the decreased water potential caused by the rise in solute concentration. The volume and turgor pressure of the cell rise as a result. The two guard cells then lengthen by bowing apart from one another, forming an open pore through which gas can diffuse, due to rings of cellulose micro fibrils that prevent the width of the guard cells from swelling and only allow the extra turgor pressure to elongate the guard cells, whose ends are held firmly in place by surrounding epidermal cells.