Explanation for studying support in plants

The first ten minutes of the class begin with a discussion with the students about the plant, such as:

- Have you ever noticed that if you roll a pea under the refrigerator and then find it a few months later, it's wrinkled and dry? If you tried to put that same pea in a bowl of water, it would swell up and return to almost its normal size again, although eating it would not be a good idea in this case. The shrinkage and swelling of peas is due to water loss or gain. This is an example of a typical scaffolding method in plant cells.Humans, as well as many animals, have a skeleton to support them, but plants do not have this property. Therefore, plants need other support mechanisms to maintain their cells, their shape, and their overall protection.

Then he begins to explain and says:

- There are two methods that plants use to maintain their shape and structure: physiological support and structural support. Physiological support is temporary and depends on the water content of the cell to maintain its shape. The synthetic support is more sustainable and depends on the deposition of solids in specific parts of the plant.

Definition: physiological support

The physiological support of the plant is temporary; Because it depends on the presence of a large volume of water in the cytosolic vacuoles of the cells, it causes turbulent pressure on the cell membranes to maintain the shape of the cell to protect it.

Definition: prosthetic support

The structural support of a plant is the permanent deposition of polymers such as lignin or cellulose in the cell walls to maintain the shape of the plant and its cells.

Complete a discussion with students about :

- The contraction and swelling of a pea shows an example of a physiological bracing mechanism, and we will consider this method of bracing first.

- You can see the cell wall, vacuole, and cell membrane of a typical plant cell in Figure 1. Plant cell walls are tough structural layers that surround the cell membrane of plants. The vacuole in a plant cell is usually a large structure filled with a fluid called cytosol, which consists of water and dissolved substances, such as sugars or enzymes. A lot of water can be stored in the vacuole, and as the volume of water stored in the vacuole increases, the cell swells. Let's take a look at how this happens and why it's important.

Key term: cell wall

The cell wall is a tough, structural layer found outside the cell membrane of the cells of plants, fungi, and bacteria.

Plant cells, such as those in peas, wrinkle and shrink when there is less water available in the area around them. This leads to the plant wilting. As the availability of water outside the cells increases, water will move into the plant across the cell membrane through osmosis. Osmosis is the movement of water molecules from an area with a low concentration of solutes to an area with a high concentration of solutes.

Definition: osmosis

Osmosis is the movement of water from an area with a low concentration of solutes to an area with a high concentration of solutes across a semi-permeable membrane.

Complete a discussion with students about:

- When the concentration of water is low inside the cells in this case, the concentration of solutes is high; Therefore, water moves from the area surrounding the plant cell to its vacuole. Because the vacuole now contains more water, its volume increases; It then causes greater pressure on the cell cytoplasm, which pushes the cell membrane toward the cell wall. This makes the wall appear swollen, and the cell bulge, at this stage, becomes large. You can see the effect of the abundant availability of water outside the cells on the swollen cell in Figure (2).

Key term: cell swelling

Cell swelling is the state in which the cell membrane pushes against the cell wall, which makes the cell swollen and solid. This usually occurs because the cell is filled with fluid.

Complete a discussion with students and say:

This process is temporary. If a plant becomes dehydrated because it does not get enough water, the cells will lose water. The loss of water from the vacuole causes the cell membrane to move away from the cell wall; Where it is exposed to less pressure. This reduces cell swelling, which ultimately causes the cell to shrink and wrinkle, as shown in Figure 2. When many plant cells shrink in this way, this causes the entire plant, especially its leaves, to wilt, as shown in the following image.

When the concentration of water in the area surrounding plant cells is higher than the concentration of water inside them, water moves into the cells through osmosis. Osmosis is the movement of water molecules from an area with a low concentration of solutes to an area with a high concentration of solutes.

Because the concentration of water is low inside the cells, the concentration of solutes is high; Therefore, water moves into the vacuole of the plant cell. The size of the sap increases; It then causes greater pressure on the cell cytoplasm, which pushes the cell membrane toward the cell wall. This makes the cell wall appear swollen, and in this case, the cell bulge is large. You can see this on the right of the following figure.

This process is temporary. If the plant does not get enough water, the cells will lose water. The loss of water from the vacuole causes the cell membrane to move away from the cell wall where it is exposed to less pressure. This reduces swelling, which ultimately makes the cell wrinkle, as we see on the left of the previous figure. When this happens to many cells

Synthetic scaffolding involves the permanent deposition of certain solid compounds into the cell wall of a plant cell. Various compounds are deposited in the walls of different cells depending on their function. Most of these compounds provide a waterproof or impermeable barrier. The compounds can also help maintain the shape of plant cells; Thus, it preserves the plant itself, and helps to maintain the uprightness and strength of the plant.

Deposition of these compounds may reduce the rate at which some substances, such as water, pass through the plant's surface, but it certainly does not increase it.

These compounds may also limit plant flexibility in some cases. Its primary function is not to allow flexibility.

It is the role of the cell membrane, not the cell wall, which provides the majority of the structural scaffolding, to control the movement of substances into and out of plant cells.

Therefore, the primary function of synthetic support materials in plants is to maintain the shape of the plant and plant cells.

The cell walls of plants are composed primarily of a carbohydrate called cellulose. Cellulose is an insoluble polymer made up of thousands of glucose molecules linked together in a chain.

You can see how cellulose forms those cell walls in the figure where an image of a leaf has gradually zoomed in to reveal the structure of its cells, its cell walls, and the cellulose itself. Cellulose is very strong, and the mesh it forms in the cell wall creates a physical barrier to support the cell.

You can see the location of the skin in the figure. Cellulose also helps keep cells swollen through the physiological response we've just seen. Cells that do not have a cell wall, such as animal cells, explode when they absorb a large amount of water. If the same condition occurred in plant cells, they would be relatively stronger; Because the solid cell wall prevents explosion. Especially in cases where cellulose is found in the external tissues of the plant, such as in the epidermis, the cellulose cell walls form a barrier to prevent disease-causing microorganisms from entering the internal tissues.

Key term: cellulose

Cellulose is the main component of plant cell walls, and is an insoluble polymer composed of chains of glucose molecules.

The epidermal cells in the leaf, which you can see in Figure (5), contain a substance called “cutin,” which is deposited in their walls. Cutin is impermeable to water; Therefore, it prevents excessive loss of water; Thus, it maintains the shape of the plant. It also increases the effectiveness of this physical barrier by increasing the thickness of the cell walls.

Key term: Cutin

Cutin is a waxy, water-repellent substance found in the cuticle of plants.

Some plants have a cork layer surrounding their organs, such as the stem. Cork usually forms after the plant has been exposed to an infection or after the leaves have dropped, and once formed, it becomes a permanent feature. Cork is impermeable, and is formed by the deposition of seoprene in the cell walls. Since it is waterproof and impermeable, cork provides another layer of protection and support against water loss and the entry of disease-causing microorganisms.

Key term: seoprene

Seoprin is an impermeable waxy substance found in the cell walls of cork plant tissue.

Lignin is a compound deposited in certain plant cell walls, such as in xylem. The xylem is part of the plant's vascular transport system, which is responsible for transporting water and minerals from the roots to the rest of the plant. You can see the basic structure of the xylem vessel in Figure 6.

When lignin is deposited in cell walls, it makes them waterproof. This is very useful for xylem; Because it reduces the chances of water leaking from the xylem vessels, which increases the efficiency of water transport. It also provides additional structural support for the xylem; It makes its vessels more rigid, which helps them stay upright to form a continuous column of water.

Key term: lignin

Lignin is a polymer found in some specialized cell walls to provide primarily mechanical support.

Key term: xylem

Xylem is a vascular tissue in plants that transports water and dissolved mineral ions from the roots to other parts of the plant.

Some other parts of the cell walls of various plant tissues can also include lignin and cellulose.