The structure and functions of the plant

Many parts of the plant are involved with the process of photosynthesis, either by helping collect the substances needed (roots, stem, leaves), storing products formed (roots, stem) or providing a place for the process to take place (leaf cells).

The Shoot System - Above ground (usually)

Lifts the plant above the soil. Main functions include:
- Leaves - photosynthesis
- Flowers - reproduction
- Fruit – seed dispersal
- Stem - food and water transport

The Root System - Underground (usually)

Anchor the plant in the soil. Main functions include:
- Absorb water and nutrients
- Transport water and nutrients
- Food Storage

Parts of a plant we eat

We use many types of plants for food. The fruit and vegetables that we eat, and grow for eating, come from various parts of the plant. We often breed types of plant for food by exaggerating a part of a plant, such as flowers of the plant to grow broccoli, to make better use of them.
The significance of photosynthesis in making food

Most living organisms depend on plants to survive. Plants convert (change) energy from sunlight into food stored as carbohydrates through photosynthesis. Because animals cannot make their own food, they must eat plants (producers) to gain nutrition. Plants produce oxygen, which is released during photosynthesis, which all organisms need for respiration.

Photosynthesis transfers energy from sunlight into energy in chemicals such as glucose and starch.

Light enters the leaf and is trapped by a green substance called chlorophyll contained within structures called the chloroplasts in the cells.

Water is transported via water tube cells called xylem, to the leaf cell and the carbon dioxide enters through the stomata and diffuses (spreads) to the leaf cells.

These substances react chemically within the chloroplasts, contained in the leaf cells; powered by the light then glucose (a sugar) is produced along with oxygen, which diffuses out. The sugar leaves the leaf via sugar/food tube cells.

Reactants and products of photosynthesis

The photosynthesis reaction can be written as a chemical equation with the reactants needed on the left and the products produced on the right.

\[
\text{light} \\
\text{Carbon dioxide} + \text{Water} \rightarrow \text{Glucose} + \text{Oxygen}
\]
The leaf is the location of most photosynthesis

The thin surface of the leaf called the blade helps capture maximum sunlight for photosynthesis. The leaf is attached by a stem to the plant, which branch out into veins. The large surface area of the leaf helps capture as much sunlight as possible. The green colour is due to chlorophyll in the leaf cells that captures the light, and where photosynthesis takes place. The leaf is thin to allow light (and carbon dioxide gas from the air) to circulate to every cell in the leaf.

Photosynthesis happens in the chloroplasts/ chlorophyll in the leaf cells

The cells at the top of the leaf are filled with chlorophyll, and allows the leaf to absorb light energy, which is required for photosynthesis. The spaces between cells in the middle allow carbon dioxide to diffuse around through the cells.

The adaptations of leaves for photosynthesis

The chloroplasts circulate around the cells, especially the layer of cells that are close to the top of the leaf. This allows maximum amounts of light to be distributed to the chloroplasts for photosynthesis to take place.

A waxy cuticle on the outside of the leaf provides a waterproof covering while remaining transparent to allow light into the leaf cells for photosynthesis.

Openings (usually on the underside of the leaf) called stomata allow carbon dioxide to enter and diffuse into cells as well as allowing oxygen to move in and out. Two guard cells on either side of the stomata open and close the openings.
Starch test

A positive test for starch is the **leaf turning blue-black** when iodine is added. The starch is the storage product of the plant when it produces photosynthesis. A positive test means photosynthesis has occurred.

**Step 1.** The leaf is boiled in water to soften it.
**Step 2.** The leaf is then placed into a boiling tube of ethanol, which is placed in a beaker of water and heated gently. This will remove the green chlorophyll.
**Step 3.** The leaf is washed in water to remove all the ethanol.
**Step 4.** Iodine added to the leaf. It will turn blue-black in the presence of starch. The starch indicates photosynthesis and the production of glucose has occurred.

Investigations into photosynthesis requirements

We can investigate that photosynthesis happens in the chloroplasts/chlorophyll in the leaf cells and use the starch test as evidence. When a plant undergoes photosynthesis, it produces glucose, which is converted into starch for storage. If we want to **investigate** what **factors** are required for **photosynthesis** we use the starch test to enable us to reach a conclusion. Factors include chlorophyll, water, carbon dioxide and light present.

Investigating if Chlorophyll is required for photosynthesis:
Select a leaf that is variegated leaf. The green parts contain chlorophyll and the white parts do not. To show chlorophyll is required for photosynthesis only the previous green areas will turn blue-black.

Investigating if light is required for photosynthesis:
Place a piece of black paper over a leaf and leave for a few days still on the plant. To show light is required for photosynthesis only the uncovered areas will turn blue-black.
1. Label the parts of the plant below

| Root hair | leaf bud | stem | fruit | flower | root | leaf |

2. Group the vegetables below into the correct plant part box

| Stem | fruit | leaf | seed | root | flower |

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3. Complete the diagram showing photosynthesis by adding the reactants going in (left) and products going out (right) of the plant.

![Diagram of photosynthesis]

4. Write the word equation for photosynthesis, using the reactants and products above.

\[ + \rightarrow + \]

5. Write down **CORRECT order** of the steps in a **starch test** by placing NUMBERS (1-13) in the box below:

<table>
<thead>
<tr>
<th>Order</th>
<th>Scrambled steps</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Place the boiling tube of ethanol in the beaker of hot water</td>
</tr>
<tr>
<td>2</td>
<td>Light the Bunsen burner to heat water</td>
</tr>
<tr>
<td>3</td>
<td>Pack up equipment</td>
</tr>
<tr>
<td>4</td>
<td>Place soft leaf in the boiling tube of ethanol and heat</td>
</tr>
<tr>
<td>5</td>
<td>Observe areas of the leaf that turn blue-black</td>
</tr>
<tr>
<td>6</td>
<td>Step up a beaker of water on a Bunsen burner</td>
</tr>
<tr>
<td>7</td>
<td>Pour ethanol in a boiling tube until it is a third full</td>
</tr>
<tr>
<td>8</td>
<td>Spread leaf on a tile</td>
</tr>
<tr>
<td>9</td>
<td>Place a leaf in the beaker of hot water</td>
</tr>
<tr>
<td>10</td>
<td>Add drops of iodine to leaf</td>
</tr>
<tr>
<td>11</td>
<td>Remove leaf from water</td>
</tr>
<tr>
<td>12</td>
<td>Rinse leaf in water</td>
</tr>
<tr>
<td>13</td>
<td>Remove leaf from the ethanol</td>
</tr>
</tbody>
</table>
Some plants have leaves that are **variegated**, where only some parts are green containing chlorophyll, while other parts are yellow or white without chlorophyll. A student wants to test if photosynthesis occurs in the parts of the leaf without chlorophyll using a **starch test**. The student needs to use a **fair test**, where only one variable, the part of the leaf has green chlorophyll or does not, is changed, while keeping all other variables the same.

Complete the investigation format sheet below of that fair test.