JUNIOR SECONDARY LEVEL SCIENCE - BIOLOGY

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BIOLOGY

MODULE 3

ENERGY AND LIFE

MODULE INTRODUCTION

All living things need energy for carrying out all their activities. Have you ever wondered where they get this energy from? Energy comes from food. Plants manufacture their own food by photosynthesis.

Other organisms obtain their food from other sources. We rely on plants and animals for food. Fruits, salads and meat are part of our daily diet. Energy is released in cells by the process of respiration.

This Module will address the issue of Energy & Respiration.

MODULE OBJECTIVES

At the end of this Module you should be able to:

- summarise the importance of photosynthesis in green plants
- show how green plants are adapted to photosynthesis
- state how energy is released
- list the types of respiration

UNIT 1

THE NEED FOR ENERGY

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UNIT 1

THE NEED FOR ENERGY

INTRODUCTION

All living organisms require energy. Even if you are lying inactive in bed, you need a minimum amount of energy for breathing, digestion, the heartbeat and for all the other metabolic reactions which keep all of us alive.

We also need energy to keep our body warm. Our body has a constant temperature of about 37^0C except when we have a temperature in cases of infections. Normally this temperature must be maintained even if the temperature of the environment is much lower or much higher. On a hot or cold day, we may feel uncomfortable but our body temperature is maintained. This process requires energy. Other activities like movement, growth and repair of tissues also require energy. In short, we need energy to keep ourselves alive. We get our energy from food. The energy is released during respiration and is then temporarily stored in a molecule called adenosine triphostate, or ATP. We can say that ATP is the energy 'currency' in all living organisms. The ATP transfers the energy to muscle tissues which use it to contract.

Plants make their own food by photosynthesis using raw materials. The rate of photosynthesis is affected by certain factors like light and temperature. Photosynthesis occurs mainly in leaves which are adapted for the process. This Unit looks at Photosynthesis and the structure responsible for this important process.

OBJECTIVES

At the end of this Unit you should be able to:

- describe photosynthesis
- list the factors that affect photosynthesis
- describe how a leaf is adapted for photosynthesis.

1.0 PHOTOSYNTHESIS – A DEFINITION

We define photosynthesis as the process during which green plants use carbon dioxide and water in the presence of sunlight and chlorophyll to produce sugars. Oxygen is produced as a by-product.

***Note**: Chlorophyll is the green pigment present in plants.*

You can represent the process by a simple equation:

$$\text{Carbon Dioxide + Water} \xrightarrow[\text{Chlorophyll}]{\text{Light energy}} \text{Sugar + Oxygen}$$

1.1 THE RAW MATERIALS OF PHOTOSYNTHESIS

The raw materials for photosynthesis are:

1. carbon dioxide
2. water

The green plants absorb carbon dioxide from the atmosphere. Carbon dioxide is constantly used up in plants during photosynthesis. Its concentration is therefore always lower than in the surrounding. Carbon dioxide therefore diffuses into the plant through tiny pores present in leaves called stomata. Later on in this unit, we'll be looking at the structure of a leaf i.e. in 1.4.

Plants obtain water from the soil. The water is drawn into the root from the surrounding soil. Root hairs greatly increase the surface area of the root for absorption.

The movement of water up the plant is discussed in Module 5, Unit 1 - 1.1.

Once inside, water moves towards the centre of the root, and then it moves up

the stem towards the leaves.

1.2 TRAPPING OF SUNLIGHT AND STORING OF ENERGY

During photosynthesis plants convert light energy into chemical energy.

How do you think this happens?

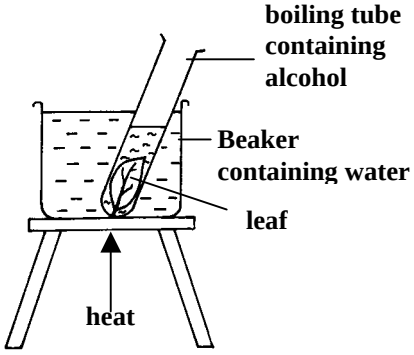
Green plants contain the pigment chlorophyll. This pigment can trap the energy from sunlight. During photosynthesis, plants use that energy to manufacture sugars. Therefore, the light energy has been converted into chemical energy which is present in the sugars.

The sugar produced during photosynthesis is glucose. Some of it is used up immediately during respiration. The excess glucose is converted into starch which is stored.

To find out if a plant has been carrying out photosynthesis, we test for the presence of starch. We do so by adding iodine solution. If starch is present, the reddish-brown iodine turns blue-black in colour.

We can now proceed with the following investigation.

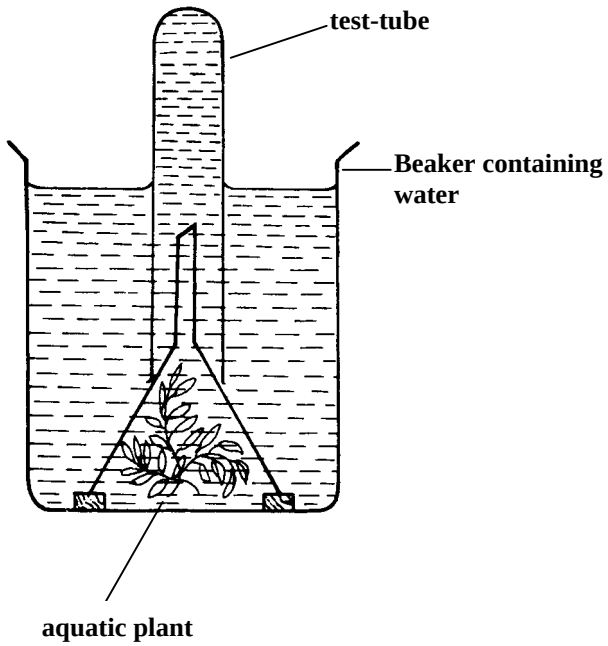
INVESTIGATION 1: To test for starch in a leaf.

For each investigation you will require the materials indicated.	**Materials needed:** • A small hibiscus or geranium leaf exposed to sunlight for a few hours • alcohol • forceps • beaker • boiling tube • bunsen burner • iodine solution • petri dish **Method:** 1. *Dip your leaf into a beaker of boiling water for about 20 seconds. This kills the leaf and softens it.* 2. *Put the boiled leaf into a boiling tube containing alcohol. Then place it into a beaker of hot water.* **Note: Never heat alcohol directly in a flame as it is flammable.** 

You should record your answers in the space provided.	*Leave the apparatus to stand for about ten minutes. The hot alcohol will decolorise the leaf.* *What is the colour of the alcohol* *a) before the leaf is put in?* …… …….. *b) after 10 minutes?* …… …… *1. Now wash the leaf in a beaker of hot water.* *2. Put the leaf in a petri dish and cover it with dilute iodine solution.* *What do you observe?* …… …… …… …….. *Is there any starch in the leaf?* …… …….. *Oxygen is produced as a by-product during photosynthesis. We can demonstrate this using an aquatic plant like <u>Hydrilla.</u>*

We can now proceed with the following investigation.

INVESTIGATION 2: To find out if oxygen is produced during photosynthesis.

For each investigation you will require the materials indicated.	**Materials needed:** • aquatic plant (e.g. Hydrilla) • funnel • test-tube • beaker • bunsen burner • wooden splint • sodium hydrogen carbonate. **Method:** *1. Set up an apparatus as shown.* 

You should record your answers in the space provided.	*2. Add a little sodium hydrogen carbonate to the water. This provides carbon dioxide to the plant.* *3. Place the beaker in direct sunlight.* **<u>Note</u>: Think of a control for this experiment and set it up.** *Observe gas bubbles formed on the leaves. These will rise up the test-tube and displace the water downwards.* *4. When the test-tube is about half filled with the gas remove it placing the thumb over its mouth.* *5. Test the gas with a glowing splinter.* *What do you observe?* …… …….. *If the glowing splinter flares up, oxygen is present.* *6. What do you conclude?* …… …… …… ……

✍ ***Before proceeding further, complete the following activity.***

ACTIVITY 1

a) *Give 2 reasons why we need energy.*

……

……

b) *How do plants obtain their food?*

……

……

You will find the answer at the end of the Module.

1.3 FACTORS AFFECTING THE RATE OF PHOTOSYNTHESIS

The rate at which photosynthesis occurs depends on a number of factors. Let's look at these factors. They are:

- light intensity
- temperature
- carbon dioxide concentration
- water

Making use of this knowledge, farmers, horticulturalists provide optimum conditions in glasshouses so that the plants photosynthesise at a maximum rate and the yield is better. All the factors affecting photosynthesis are carefully controlled in the glasshouse.

1.3.1 LIGHT

Bright light is shone on the plants even during the night.
However, very bright light can actually slow down the rate of photosynthesis. Therefore, an optimum light intensity is used at which plants will photosynthesise at a maximum rate.

1.3.2 TEMPERATURE

The higher the temperature, the faster the rate of photosynthesis. This applies to temperatures below 40º C. Can you guess why? This is because heat destroys enzymes which drive the process of photosynthesis. In glasshouses a constant, optimum temperature of 40º C is maintained.

1.3.3 CARBON DIOXIDE CONCENTRATION

The higher the carbon dioxide concentration, the faster the rate of photosynthesis. Extra carbon dioxide is pumped into glasshouses to increase the yield.

1.3.4 WATER

Plants need a good supply of water for maximum photosynthesis. In greenhouses, a controlled amount of water is supplied to plants.

1.4 LEAF STRUCTURE

The leaf is the main photosynthetic organ of a plant. It has both external and internal features which adapt it to its function. Let us first have a look at the adaptations you can see from the outside.