

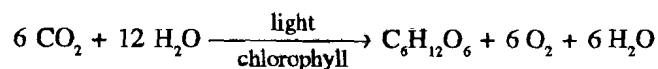
# 5 EFFECT OF LIGHT QUALITY AND INTENSITY ON PHOTOSYNTHESIS

---

## 5.1 INTRODUCTION

---

The complex process of photosynthesis can be summarised by the following general equation:



The rate of photosynthesis can be measured by intake of  $\text{CO}_2$  or release of  $\text{O}_2$ . In this exercise you would use a manometer to measure the volume of  $\text{O}_2$  evolved. Since  $\text{O}_2$  is taken in during the process of respiration which operates in the dark as well as light, the observed rates of photosynthesis are corrected by performing the controls in the dark to know the intake of oxygen during respiration.

The rate of photosynthesis is affected by three environmental factors - quality and intensity of light, concentration of  $\text{CO}_2$  and temperature. In this exercise you will study the effect of quality and intensity of light on the rate of photosynthesis in bean plant.

### Objectives

After doing this experiment you should be able to:

- measure the rates of photosynthesis under different conditions of light.

---

## 5.2 MATERIALS REQUIRED

---

any young fresh green leaves

pipette manometer (use the assembly prepared for Exp.2)

table lamp—60 watt bulb with internal reflector

1% solution of sodium bicarbonate

flask (500 ml)

thermometer

stop clock

cotton wad

large sheet of black paper

cork borer (1 cm)

---

## 5.3 PROCEDURE

---

(Work in team of four)

The simple pipette manometer used for measuring the rate of respiration will be used for the following three experiments on photosynthesis.

### A Measurement of Rate of Photosynthesis

1. Clean the manometer thoroughly and dry it before use.
2. Pour 2 ml of 1% sodium bicarbonate solution into the tube. Make sure that it does not touch the sides of the test tube. Now insert a cotton wad in the tube to partition bicarbonate solution.

- Cut several discs of leaves with 1 cm diameter cork borer and keep them moist in petridish in the dark. Insert one piece in the tube and place it vertically on the cotton wad.
- Assemble the apparatus and place it in a 500 ml flask containing water at room temperature. Cover the flask with black paper thoroughly. Let it equilibrate for 5 to 10 minutes.
- Introduce a drop of marker dye in the pipette and adjust it towards a mark to extreme right.
- Start stop watch and note the readings on pipette immediately and after an interval of 5 and 10 minutes.
- Now adjust the black paper to make a vertical slit so that the leaf can be exposed to light source. Keep the light source 10 cm away from the apparatus.
- Adjust the marker drop to the extreme left upto a mark.
- Take readings at zero time and after an interval of 5, 10, 15, 20 and 25 minutes.

Time	$\mu\text{l}$ of $\text{O}_2$ consumed in the dark	$\mu\text{l}$ of $\text{O}_2$ evolved in light
0		
5		
10		
15		
20		
25		

**B Effect of Light Quality on the Rate of Photosynthesis**

- Cover the light source with green, blue or red cellophane paper and take the readings as in the previous experiment.

Time	$\mu\text{l}$ of $\text{O}_2$ evolved in green light	$\mu\text{l}$ of $\text{O}_2$ evolved in blue light	$\mu\text{l}$ of $\text{O}_2$ evolved in red light
0			
5			
10			
15			

**C Effect of Light Intensity on the Rate of Photosynthesis**

- Keep a beaker full of water between light source and the leaf disc. Take the readings as before by moving the light source at a distance of 10, 15, 20, 30, 40 and 50 cm. away from leaf sample (the intensity of light varies inversely as a square of distance =  $(I \propto \frac{1}{d^2})$ ). Get two to three readings at the same intensity at 5 minute intervals.

Distance of light source	$\mu\text{l}$ of $\text{O}_2$ evolved/5 min	$\mu\text{l}$ of $\text{O}_2$ evolved/10 min	$\mu\text{l}$ of $\text{O}_2$ evolved/min
10			
20			
30			
40			
50			

---

## 5.4 RESULTS

---

Make the following plots:

1.  $\mu\text{l}$  of  $\text{O}_2$  evolved/min/cm<sup>2</sup> of leaf against time with fixed light source.

2.  $\mu\text{l}$  of  $\text{O}_2$  evolved/min/cm<sup>2</sup> of leaf against varying light intensity ( $\frac{1}{d^2}$ )

Calculate the rate of photosynthesis

$$\text{rate} = \frac{\mu\text{l of O}_2 \text{ evolved} + \text{O}_2 \text{ taken up in the dark}}{\text{wt in g of leaf} \times \text{time in hours}}$$

Indicate the rate of photosynthesis in increasing order below when different colours of light are used.

.....

---

## 5.5 PRECAUTIONS

---

1. Make sure that pipette is kept in horizontal position.
2. The whole system must be air-tight. Perform a check before use (see exp. 2).
3. Do not grease the rubber bung.
4. Loosen pinch clip while you equilibrate the assembly.
5. The equilibration of the apparatus should be done before taking the readings.
6. Keep a beaker filled with water between the light source and specimen for experiment c.

### SAQ

1. What would be the pattern of gas exchange between plant and environment during night, early morning, noon and evening?

.....  
.....  
.....

2. Why is sodium bicarbonate solution taken in the test tube?

.....  
.....

3. Why is marker positioned at the right extreme of pipette during respiration and at the left extreme during photosynthesis?

.....  
.....