MEASURING THE RATE OF PHOTOSYNTHESIS IN *ELODEA*

PLANNING A:

AIM: To investigate the rate of photosynthesis in *Elodea* under different circumstances using pH as the measurement.

INTRODUCTION:

The process in green plants and algae that allows them to produc e their own food sources and continually regenerate oxygen in the environment is called photosynthesis. This process, undertaken by green plants, nourishes almost the entire living world either directly or indirectly, as the path of the food chain is trace d from plants up through animals. Photosynthesis comes from two words, photo meaning "light" and synthesis meaning "to make".

Photosynthesis occurs to furnish life, directly or indirectly, with chemical energy in organisms. Plants use photosynthesis as a means of obtaining energy from sunlight, converting it and store it as chemical energy – 'packets' called ATP. These energy packets are, in turn, used with carbon dioxide to build a variety of chemicals in the plant, including carbohydrates, fats and proteins - the common compounds we call food. When animals eat plants as food, they break down, or metabolise food compounds to small molecules. Some of these molecules are used to build more complex structures, such as bones and muscles in every part of ou r bodies. In essence, photosynthesis provides food for most forms of life on Earth, including humans.

The photosynthesis reaction begins with carbon dioxide taken from the air and water absorbed from the soil. Within the plant, special structures called c hloroplasts contain sunlight-absorbing pigments, known as chlorophyll. The energy converted by these pigments from the sunlight powers the conversion of air and water to oxygen, which is released to the environment, and to a sugar called glucose, which is an excellent storage molecule for energy. Glucose can later be stored in the form of starch or transformed into ATP, which is used as the 'fuel' of all living things.

The chemical equation for photosynthesis is:

Carbon Dioxide + Water + Light Energy → Glucose and Oxygen

$6CO_2 + 12\ H_2O$ + light energy → $C_6H_{12}O_6 + 6O_2 + 6H_2O$

In the process of photosynthesis, several factors may affect its execution or results, including the temperature, light intensity and presence of CO_2. Similarly, there are also several ways to determine the rate of photosynthesis, such as measuring the amount of oxygen produced, measuring the mass of the plant or testing to find an increase or decrease in pH. In this experiment, we are investigating the effects of light intensity on photosyn thesis using pH as a form of measurement. As chlorophyll uses light energy to perform photosynthesis, it can only do it as fast as the light is arriving. Chlorophyll only absorbs the red and blue ends of the visible spectrum but not the green light in the middle, which is reflected back. If the light level is raised the rate of photosynthesis will increase steadily but only to a certain point. In water plants, photosynthesis can be measured using pH as carbon dioxide in water makes a slightly acidic solutio n - carbonated mineral water. A fter photosynthesis has occurred, a change will occur in the concentration of carbon dioxide and the rate of photosynthesis can be determined by recording the change in pH.

HYPOTHESIS:

If the photosynthesis has occurred, then the solution will be more basic (pH will increase).

In photosynthesis, carbon dioxide is exhausted and thus the combination of water and carbon dioxide (carbonic acid) will contain less carbon dioxide. The less amount of carbon dioxide in the solution, the less acidic it becomes and thus the solution will become more basic and the pH will increase.

If photosynthesis has not occurred, then the solution will be more acidic (pH will decrease).

If there is no photosynthesis, but there is a green plant present, the plant will *assumedly* undergo the process of respiration, that is, the reversal of photosynthesis, creating carbon dioxide and water. Therefore, with more carbon dioxide manufactured, the solution will become more acidic and the pH will decrease .

If there is no green plant present, then photosynthesis cannot occur.

Photosynthesis can only occur with the combination of a green plant, carbon dioxide and light energy.

VARIABLES:

Independent Variable: Exposure to light
Dependent Variable: Change in pH
Constant Variable: Amount of sodium bicarbonate, distilled water and plant/lack of plant
Uncontrollable Variable: Accuracy of pH meter

DATA COLLECTION:

TABLE 1 – *pH of Solution Before and After Incubation in the Light or Dark*

CONDITIONS	**pH**	
	BEFORE	**AFTER**
Exposure to Light	8.3	10.5
No Exposure to Light	8.3	8.0
Control (without *Elodea*)	8.3	8.1

UNCERTAINTY: ± 0.05 pH units

CONCLUSION AND EVALUATION:

In this experiment, the effect of light intensity on photosynthesis in the plant Elodea was investigated using pH as a form of measurement. The results gained supported the hypothesis:

- In a darkened environment, the pH of the solution in which the plant was immersed was lower, and more acidic.
- In a lightened environment, the pH of the solution in which the plant was immersed was higher, and more basic.
- Photosynthesis did not occur without the presence of a green plant

However, there was a change recorded in the control, where there was no plant, therefore respiration or photosynthesis could not take place, however the solution became more acidic. This was probably due to contamination of the pH meter.

ERRORS AND THEIR EFFECTS	IMPROVEMENTS
Difference between photosynthesis and respiration. Plant only respires at night and there is an assumption that is respires during the day but at a lower rate than photosynthesis.	Include more test tubes in which respiration is measured, both at night and during the day to confirm assumption.
Experiment only carried out for 22 hours as opposed to 40 so results were not as precise.	Carry experiment out for 40 hours to gain more accurate results.
The *Elodea* was dying during the process of drying therefore affecting its ability to photosynthesise at an optimum rate.	
Some carbon dioxide was released before the plant was placed in the test tube, affecting the amount of carbon dioxide in the solution.	Stopper flask/test tube immediately after mixing solution and inserting plant.
Miscalculation of pH due to contamination, pH meter was not placed in buffer each time thus affecting pH recorded.	Ensure the meter is placed in buffer each time after recording pH.