

Helping Grade Nines with Photosynthesis

Imagine some grade 9 kids are doing a science fair project to investigate the role of the chloroplast in photosynthesis but they're in over their heads and need your help. They've set up four tubes as described in Table 1. The blue dye is a chemical called DPIP (2,6-dichlorophenol-indophenol) and was added to show when photosynthesis occurred. When DPIP is reduced by accepting electrons, it changes from blue to colorless.

Table 1: Preparation of first set of test tubes

Tube 1	Tube 2	Tube 3	Tube 4
Fresh chloroplasts	Fresh chloroplasts	Boiled chloroplasts	No chloroplasts
Buffer*	Buffer*	Buffer*	Buffer*
DPIP	DPIP	DPIP	DPIP
Placed in the dark	Placed in the light	Placed in the light	

* A *buffer* is a chemical that helps a solution maintain a constant pH

1. [SP 3, SP 6] Before reading any further, predict in which tube(s) photosynthesis should occur and justify your choice.

The students used an instrument called a spectrophotometer to measure how much light passes through the sample in each tube (called the transmittance). To make their measurements, the students placed each tube in the spectrophotometer briefly at each time point. The tubes were then placed immediately back in the experimental conditions. The data they collected are shown in Table 2.

2: Transmittance of light through each tube each tube

Tube	Time (min)			
	0	5	10	15
1	32.3	33.5	35.5	34.8
2	32.7	54.5	63.7	65.1
3	32.7	32.9	33.7	32.5
4	31.3	31.3	31.3	31.3

2. [SP 3] State the purpose of each of the four tubes.
3. [SP 4, SP 6] Identify the tube in which photosynthesis occurred. Justify your choice.
4. [SP 1, SP 6] a) State and explain the effect boiling the chloroplasts had on photosynthesis.
b) Describe how the data support your answer in (a).
5. [SP 3] Identify the molecule found in chloroplasts that is replaced by DPIP in the experiment.
6. [SP 1, SP 6] Identify the source of the electrons that reduce DPIP.
7. [SP 1, SP 4, SP 6] Explain why the increase in transmittance allows you to conclude that photosynthesis has occurred.

8. [SP 4] Explain the difference in the transmittance in tubes 1 and 2.

The minor niners were so excited by how awesome you were, they asked you to help some friends who were also struggling. The second group of students were investigating the gas exchange that occurs during photosynthesis. They know that carbon dioxide is soluble in water at room temperature and oxygen is not very soluble in water at room temperature. They found out by using Google that the pH of water decreases as carbon dioxide dissolves in it. Their teacher also told them that the pH indicator phenol red is yellow below pH 6.4 and red above pH 8.0. It goes through shades of orange in between those two. For their experiment they used a little aquatic plant called Elodea. They prepared 3 test tubes as described in Table 3 and recorded their observations in Table 4.

Table 3: Preparation of Elodea tubes

Tube 1	Tube 2	Tube 3
Phenol red Water Elodea placed in the light	Phenol red Water Elodea placed in the dark	Phenol red Water Placed in the dark

Table 4: Color change and bubble formation in Elodea tubes

Time (min)	Tube 1		Tube 2		Tube 3	
	Color	Bubbles	Color	Bubbles	Color	Bubbles
0	Orange-red	No	Orange-red	No	Orange-red	No
120	Dark red	Yes	Yellow	No	Orange-red	No

9. [SP 4, SP 6] a) Explain the connection between the color changes in Tubes 1 and 2 and the changes in the carbon dioxide concentration.
b) Describe the cause of the changes in carbon dioxide concentration.
10. [SP 4, SP 6] Explain the presence of bubbles in Tube 1.
11. [SP 3] The students realized nothing happened in Tube 3 so they wondered why it was even necessary. What would you say?