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| Science 08 – UNIS Hanoi |
| Rates of photosynthesis lab |
| Plants Unit |
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**B. Aim:** Photosynthesis is the process when green plants use sunlight to synthesize its own organic matter from carbon dioxide (CO2) and water (H2O). Generally in plants, photosynthesis involves green pigment chlorophyll and generating oxygen (O2) as a secondary result. The speed of the oxygen production, otherwise known as rate of photosynthesis can be affected by many factors such as the amount of carbon dioxide or water supply, temperature, color of the leaf… In this lab, the purpose is to investigate another one of the factors: What are the effects of **light intensity** on the rate of photosynthesis of green leafs through the observation of floating leaf discs?

**C. Variables:**

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|  | **Variable?** | **How?** |
| **Independent**  **Variable** | Light intensity | For this experiment, I will manipulate the light intensity by changing the distance from the light source to the syringe in order to notice its impact on the photosynthesis rate. The higher light intensity “A syringe” will be placed directly below the neon light source while the lower light intensity “B syringe” will be place about 10cm (maybe less or more depending on the size of the neon light) away from the light source. |
| **Dependent**  **Variable** | The rate of photosynthesis  (minutes) | Using a stop watch, I will measure the amount of time it takes for 5 leafs to reach the 5cc point (half way up) in each syringe and then record/compare the difference in data between the lower light intensity “A syringe” photosynthesis rate vs. the higher light intensity “B syringe” photosynthesis rate. |
| **Control**  **Variable** | The same plant | I will select one specific plant in the school garden to be the only leaf supplier for my experiment. |
|  | The same amount of sodium carbon dioxide (baking soda) | I will constantly use 20g of baking soda which I will weigh using a ... to be exact and then mix it into 1l of water |
|  | The same light source | Throughout the experiment, I will be using the same neon light that is provided by the teacher to ensure the accuracy of the data. |

**D. Hypothesis:**

If the leafs are exposed to a higher level of light intensity then it will take less time for the leaf discs to rise within the baking soda solution because the more light there are, the more it excites the chlorophyll molecules in the leafs, providing energy to increase the rate of O2 production through photosynthesis, which I will testify by comparing how long it takes for 5 leaf discs to float half way in the high light intensity “syringe A” to the low light intensity “syringe B”. In my prediction, it will take 10 minutes for 5 leaf discs in “syringe A” to float up to the 5cc point, meaning it will be about 2 times faster than “syringe B” which will take roughly around 20 minutes.

**E. Equipment and materials:**

* 1 Hole puncher
* 2 plastic syringe (10cc or more)
* One 2000ml beaker
* 1 forceps
* Green leaf material (at least 6 leafs)
* Sodium bicarbonate (Baking soda)
* Artifial light source
* Syringe holder
* Timer
* White paper

**F. Method:**

1. Prepare two syringes and mark one of them with a sticky note with the letter “A” and the other with “B”.
2. Pour 1l of tap water into the 2000ml beaker and mix a solution with 20g of baking soda
3. Grab a hole puncher and punch out 20 leaf discs from a green leaf onto a white piece of paper
4. Remove the plunger from the “A syringe” and add one leaf disc at a time into the syringe barrel using a forceps
5. Replace the plunger again, push it nearly to the bottom and suck up 10cc of the baking soda solution
6. Hold your finger in the end of the syringe and do the Lift-Push motion with the plunger slowly to pull the air out as much as possible in order to make all the leaf discs fall to the bottom
7. Squeeze out most of the baking soda solution until you have a couple cc left once all the leaf discs have sink down
8. Fill up 10cc of tap water (no baking soda) inside the syringe
9. Place the “A syringe” in a holder directly below the neon light source and start timing
10. Observe the leaf discs and write down some notes about qualitative data and observations.
11. Stop the stopwatch once 5 leaf discs have passed the 5cc point.
12. Record the data/rate of photosynthesis in the unit of minutes for “syringe A” down on a table
13. Redo the same process for “syringe B” from step 3 to step 8 and then place the syringe with the syringe holder 10cm away from the light source.
14. Observe the leaf discs and write down some notes about qualitative data and observations.
15. Stop the stopwatch once 5 leaf discs have passed the 5cc point.
16. Record the data/rate of photosynthesis in the unit of minutes for “syringe B” down on a table
17. Rinse out the equipment (except for the baking soda solution) and repeat everything from step 1 to 14 (skip step 2) for at least 2 more trials.

**G. Diagram of apparatus:**

Light source

Syringe B

Stopwatch

Syringe A

**H. Observation:**

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| Light intensity | Qualitative data |
| High | 1 minute - The leaves stay on the bottom, no changes  3 minutes - Some leaves are starting to rise up a bit, forming multiple tiny bubble on the bottom side  5 minutes - One leaf is close to the 5 cc point; the others are also starting to go up at the same time.  7 minutes - The bubbles underneath is bigger and instead being tiny and many at first, it’s now separated into individual big bubbles.  9 minutes - The leaves are now rising up sideways very quickly comparing to the first 5 minutes. The bubbles have now disappeared.  11 minutes - Five leaves have completely passed half way and still continuing to rise up to the surface |
| Low | 1 minutes - The leaves stay on the bottom, no changes  5 minutes - The leaves stay on the bottom; two leaves are starting to lift upwards.  10 minutes - Tiny bubbles are starting to form underneath all the leaves, two leaves are close to 5cc point  15 minutes - The bubbles are clearly separated into individual big bubbles; One leaf has passed the halfway point, two leaves below are still rising up  20 minutes - Three leaves have passed the 5cc point, all of the leaves that were on the bottom are now all rising up rapidly at different levels  22 minutes - Five leaves in specific, along with others as well have now passed the halfway point completely. |

**I. Processing and presenting data:**

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|  | Time (minutes) - Trial 1 | Time (minutes) -Trial 2 | Time (minutes) - Trial 3 | Time (minutes) - Average |
| High light intensity (Syringe A) | 11.37 | 15.11 | 9.81 | 12.1 |
| Low light intensity  (Syringe B) | 22.32 | 26.54 | 21.82 | 23.56 |

**Transformed data:**

* Average of the photosynthesis rate of leaf discs under high light intensity in three trials:

(11.37 +15.11 + 9.81) / 3 = 12.1

* Average of the photosynthesis rate of leaf discs under low light intensity in three trials:

(22.32 + 26.54 + 21.82) / 3 = 23.56

* Difference between the photosynthesis rate averages of leaf discs under low light intensity and the leaf discs under high intensity :

23.56 – 12.1 = 11.46

* How much shorter in times does the photosynthesis of leaf discs under high light intensity took to occur compared to the leaf discs under low light intensity?

23.56/12.1 = 1.9 times ≈ 2 times

**J. Conclusion:**

1. Was your hypothesis supported by your results or not? Explain by describing the trends or patterns of the data and discussing the results with scientific reasoning.

My hypothesis was supported by my results because all of my predictions from the beginning were quite close the final data. According to my hypothesis, I clearly stated that the higher the light intensity is, the more effect it will take on the photosynthesis rate of the leaf discs, making it process faster as the light energy excites the chlorophyll molecules. As you can see from the data table and graph, there is a specific pattern involved in the results: The amount of time it took for the leaf discs to rise up in “Syringe A” is always lower than the ones in “Syringe B” for all the three trials that were recorded. For example in average, the leaf discs in “Syringe A” took only 12.1 minutes to go pass the halfway point, while in “Syringe B”, it took 23.56 minutes for the leaf disc to reach 5cc.

Furthermore, the final results have also proven the quantitative data in hypothesis to be near precision. In my hypothesis, I have predicted the dependent variable that was affected by light intensity (independent variable) of the “Syringe A” will be twice as shorter in “Syringe B” which was place 10cm away from the neon light. This prediction was only 0.1 away from the actual result. Also, since from the beginning, I have told in specific that my prediction for the leaf discs in “Syringe A” to float halfway will be around 10 minutes and the leaf discs in “Syringe B” will be roughly around 20 minutes, then this means that the average of my resulting data were both only about 1 minute away for each.

2. Answer the purpose of the experiment: What are the effects of **light intensity** on the rate of photosynthesis of green leafs through the observation of floating leaf discs?

Normally, light energy is absorbed by the chlorophyll in order to for the photosynthesis process to happen. But under high or low light intensity, the photosynthesis rate might be stronger or weaker, causing it to occur at different timing. At a low light intensity, it might take a long amount of time for photosynthesis to process or not happen at all if the leaf only respires but not photosynthesizing. At a high light intensity, the photosynthesis will occur much quicker until it’s completely done and reaches the constant level.

**K. Evaluation:**

1. Discuss in detail of whether the method has allowed the collection of valid data (reliable and relevant).

The method has provided enough detailed directions to allow data collection to be reliable and relevant. In the method, step 1 and 2 was the preparation part which helps the person doing the experiment to identify the materials without confusions. From step 3 to 9 were the actual experimental part of the lab which should be the most difficult area to perform correctly. The last steps in the directions were the recording all the necessary data in order to answer the aim and conclude the lab. Overall, I have been able mentioned all of the required materials, detailed steps into performing the experiment, as well as all the variables (independent, dependent, constant) with the unit of measurement which is minutes.

2. Were there any weaknesses in the experiment? How could this experiment be improved if we did it again?

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| Weakness | Improvement |
| Complication in directing the method | In the method part, the directions are written in very long sentences and possibly too many details that may confuse the reader. Next time, there will be improvements made to the method by instead of combining multiple ideas into one line; I will separate them into multiple steps with a clearer purpose. I will also try including tips and quick tricks into getting a specific step done if possible. |
| Possible inaccurate results due to unclear controlled variables | In the variable part, I should’ve added more constant variables and how I will control them because I think this little mistake can make the final data slightly inaccurate. Next time if I do this experiment again, I will add to each variable the reason why this need to be done and a couple extra ones that are important such as the water temperature or the type of neon light (warm - orange colored or cold-white colored). |
| Minimal diversity in ways of transforming data | In the transforming data part, I’ve only used the basics of calculating to apply to the comparison system. Next time, I will challenge myself and try new ways to transform my data such as multiplication or percentage. |

3. State a few things that made this experiment a FAIR TEST (or not)?

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| * This was a fair test because there were only one independent variable (the one that changes) and one dependent variable (the one that is affected by independent variables). For example the one independent variable is the “light intensity” and the dependent is the “rate of photosynthesis” in leaf discs. * This was also a fair test because the experiments with both light intensities (high and low) are each tested for 3 trials. This was important because it’s one of the factors to ensure the reliability and validity of the results. |

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