Photosynthesis

In this session, photosynthesis will be explored. Experiment 1 will look at using seaweed, bicarbonate indicator and colorimetry to quantify the consumption of atmospheric carbon dioxide through photosynthesis. Experiment 2 will look at the ability of green plants, including algae, to photosynthesise and respire. In experiment 3 and 4, a couple of simple experiments will be used to demonstration the impact of “human activity” on ocean acidification and the restorative potential of plants.

**Experiment 1 – Using colorimetry**

***Aim***: To investigate the effect of light intensity on photosynthesis in seaweed

**Materials required (per pair):**

|  |  |
| --- | --- |
| 5x bijou bottles | Neutral density filters (filter number 209 and 210 to allow 51% and 24% light transmission, respectively) |
| Bladderwrack seaweed | Black paper |
| 2x Universals of bicarbonate indicator (air-saturated) | Colorimeter |
| Scissors | 5x cuvettes |
| Forceps | 3 cm3 dropping pipettes |
| Access to a balance | Marker pen |
| Weigh boat | Access to fluorescent tube light |
| 50 cm3 beaker (1/2 full of distilled water) | Stopwatch |
| Bicarbonate indicator colour chart |  |

**Method - in pairs**

1. Cut 4 pieces of seaweed of same length, avoiding air bladders.
2. Store the seaweed samples in distilled water until they are used in Step 4 below.
3. Line up 5 empty Bijou bottles (each bottle has a volume of approximately 7 cm3). Rinse the first bottle with approximately 2 - 3 cm3 of bicarbonate indicator and transfer the indicator to the second bottle. Repeat until all 5 bottles have been rinsed.
4. Place a sample of seaweed into 4 of the rinsed Bijou bottles.
5. Fill all 5 Bijou bottles with bicarbonate indicator and write your initials on the lid.
6. You are provided with 3 pre-formed filter sleeves which will allow either 50%, 25% or 0% of light to be transmitted. Place these filters over 3 of your Bijou bottles containing seaweed.
7. The 2 remaining bottles – one containing seaweed & indicator and one containing just indicator - will not be covered.

1. Line all 5 bottles under one of the fluorescent tubes and note the time.
2. Leave the samples in front of the lamp for a period of 25 min.
3. Thoroughly mix the contents of each Bijou bottle.

A group of bottles with orange liquid

Description automatically generated

1. You are going to use the colorimeter to record the absorbance values of your solutions.

The controls for the colorimeter are relatively simple:

|  |  |
| --- | --- |
| c00363267 | *Power switch turns the unit on. The unit switches off after about 2 minutes to conserve battery power.* |
| ***CAL*** | *Calibrates the unit to 0.000 absorbance or 100.0% transmittance* |
| ***RGB*** | *Switches between the red, green and blue light sources* |
| ***A/T*** | *Switches display between absorbance and transmittance* |

|  |  |
| --- | --- |
| 1. ***Figure_1_colorimeter***Switch on the colorimeter. 2. Select the green diode by pressing **RGB** until **‘G’** appears in the top left-hand side of the display screen. 3. Select absorbance by pressing **A/T** until **A** appears in the top right-hand side of the display screen. 4. Place a cuvette containing distilled water into the sample holder and press ‘CAL’ to zero the colorimeter. **Note the** direction of the light beam - ensure the cuvette is in the correct orientation. Record the absorbance (it should read 0.00 |  |

1. Empty the cuvette and replace with the indicator from the Bijou bottle which did not contain any seaweed and measure the absorbance.
2. Measure and record the absorbance of the 4 remaining Bijou bottles starting with 0% light transmitted.

**Results**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Light intensity (%)** | **Absorbance of light by indicator** | | | | |
| **1** | **2** | **3** | **Mean** | **Corrected mean** |
| 0 |  |  |  |  |  |
| 24 |  |  |  |  |  |
| 51 |  |  |  |  |  |
| 100 |  |  |  |  |  |

|  |
| --- |
| *Absorbance of indicator on its own (bijou 1):\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_*  *This must be subtracted from all mean values to account for the initial absorbance of the indicator in the absence of biochemical reactions by the plant.* |

*Alternatives to using colorimetry*

A row of small bottles with different colored liquids

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|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Light intensity (%)** | **pH of indicator** | | | |
| **Trial 1** | **Trial 2** | **Trial 3** | **Average** |
| 0 |  |  |  |  |
| 24 |  |  |  |  |
| 51 |  |  |  |  |
| 100 |  |  |  |  |

**Experiment 2: Observing photosynthesis and respiration using algae**

**Aim**: To investigate the effect of light on photosynthesis and respiration in algae

**Materials required (per pair):**

|  |  |
| --- | --- |
| 50 cm3 bicarbonate indicator | Filter funnel |
| 5 cm3 concentrated suspension of *Scenedesmus quadricauda* | 20 cm x 6 cm length of black bin bag |
| 50 cm length of glass tubing (internal diameter ~1cm) with 2 rubber bungs | Access to a light source (preferably fluorescent) |
| 100 cm3 beaker | 2x retort stands / or suitable alternative |
| Stirring rod | Ruler |
| Scissors | Sellotape |

**Method:**

1. Check the size of the black bin bag. The material should fit snugly around half of the glass tube, without being too tight – this will need to be removed tomorrow without disturbing the contents.
2. Firmly stopper one end of the glass tube.
3. Add 5 cm3 algae to a beaker and add sufficient bicarbonate indicator to give a final volume of 50 cm3.
4. Stir the mixture and add to the glass tube as quickly as possible. Top up the tube with indicator leaving about 1 cm3. Add the second stopper.
5. Give the tube a thorough mix to ensure the algal suspension is uniformly distributed.
6. Wrap the bin bag cutting around the left half of the tube and secure with Sellotape.
7. Place the tube under a light bank, resting in the wooden support provided. Alternatively, the tube could be clamped between two retort stands.
8. Leave for a couple of hours (or up to 24 hours) and observe the results. Carefully, without disturbing the contents of the tube, remove the black material to observe the effect of respiration in the “dark zone” and photosynthesis where the algae accessed light fully.

A screenshot of a video game

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