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VCE Biology ¾
AOS 2 Revision [2.0]
SAC 1 Solutions

43 Marks. 5 Minutes Reading. 65 Minutes Writing.

Section A: Additional Random, Non-Experiment Specific Questions (43 Marks)

Question 1 (4 marks)

Write an introduction to photosynthesis and cellular respiration. Discuss the factors that influence these biological processes, as well as what makes these processes biochemical pathways.

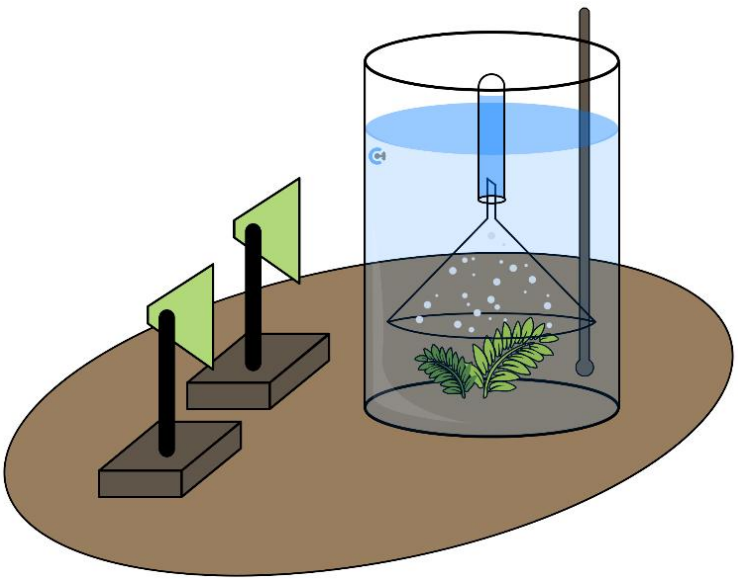
Photosynthesis and cellular respiration are essential biochemical pathways that facilitate energy transformation in living organisms. Photosynthesis occurs in chloroplasts, where light energy is used to convert carbon dioxide and water into glucose and oxygen. This process includes the light-dependent reactions in the thylakoid membranes and the Calvin cycle in the stroma. Aerobic cellular respiration takes place in mitochondria, where glucose is broken down along with oxygen to produce 30 or 32 ATP, water, and carbon dioxide. It includes glycolysis in the cytosol, the Krebs cycle in the mitochondrial matrix, and the electron transport chain in the cristae. Factors such as temperature, pH, substrate (CO_2) for photosynthesis and glucose for cellular respiration) and enzyme concentration and light intensity in photosynthesis influence these processes. Both are considered biochemical pathways due to their series of enzyme-catalysed reactions that systematically convert substrates into products of each respective pathway.

Space for Personal Notes

Title: Investigating Photosynthesis in Spinach Leaves

- Aim: To investigate the rate of photosynthesis in spinach leaves under varying light intensities.
- Materials:
  - Spinach leaves.
  - Beakers.
  - Water.
  - Sodium bicarbonate (Baking soda).
  - Light source (e.g., Lamp).
  - Timer.
  - Ruler.
  - Test tubes.
  - Alcohol.
  - Boiling water bath.
- Ice bath.
- Procedure:
- Preparation of Spinach Leaves:
  - Obtain fresh spinach leaves and immerse them in water to remove any dirt or debris.
  - Cut the spinach leaves into uniform-sized discs using a hole puncher or a sharp knife.
  - Place the spinach leaf discs in a beaker filled with water to prevent them from drying out.

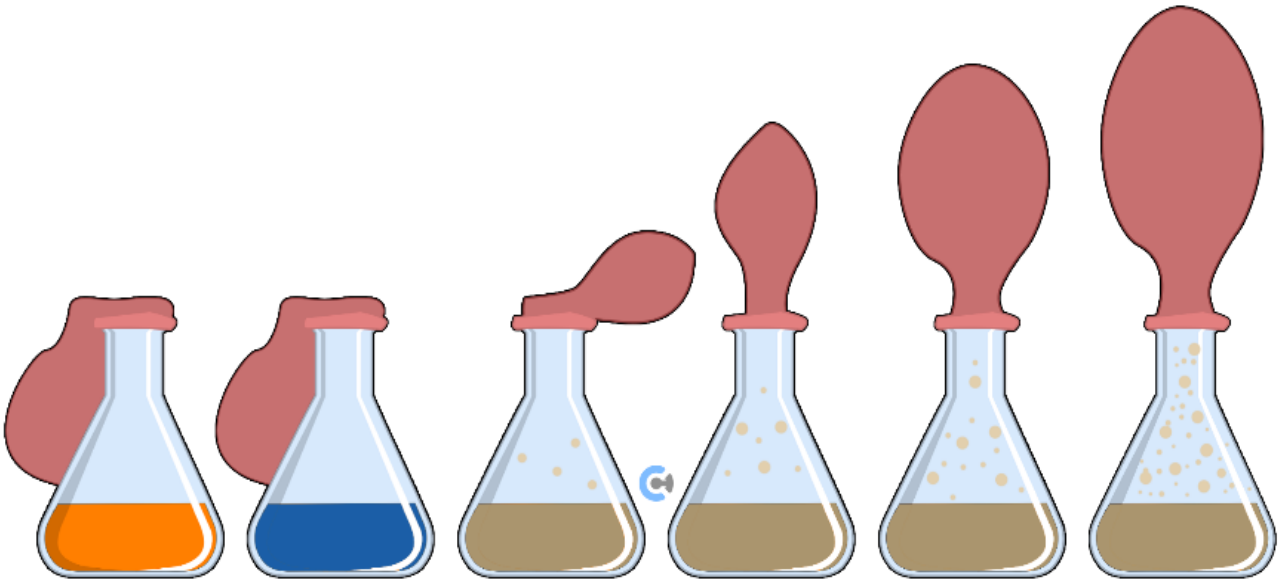
- Setup of Experimental Apparatus:
  - Fill four test tubes with water and place them in a test tube rack.
  - Add a small amount of sodium bicarbonate (baking soda) to each test tube.
  - Set up a light source (lamp) at varying distances from the spinach leaf discs to create different light intensities (e.g., $10\ cm$, $20\ cm$ and $30\ cm$), as well as placing one test tube in a box with no exposure to light.
  - Ensure that the light source is stable and directed towards the spinach leaf discs.
- Experiment:
  - Place one spinach leaf disc into each test tube containing the sodium bicarbonate solution.
  - Start the timer and immediately place the test tubes under the respective light sources, except for the negative control which will be kept in darkness.
  - Allow the spinach leaf discs to undergo photosynthesis for a set duration (e.g., 7 days).
  - After the set time, remove the test tubes from the light sources and stop the timer.
- Analysis:
  - Carefully remove the spinach leaf discs from the test tubes and blot them dry with paper towels.
  - Measure the diameter of each spinach leaf disc using a ruler and record the values.
  - Calculate the change in diameter (growth) for each spinach leaf disc.



Title: Investigating the Effect of Glucose Concentration on Balloon Diameter Due to Yeast Fermentation

- Aim:
  - To investigate how varying concentrations of glucose affect the diameter of a balloon due to yeast fermentation and the release of carbon dioxide.
- Materials:
  - Balloons (same size).
  - Glucose solutions of varying concentrations (e.g., $0\%, 1\%, 2\%, 5\%$).
  - Active dry yeast.
  - Warm water.
  - Graduated cylinder or measuring cup.
  - Funnel.
  - Timer.
  - Marker.
  - String or ruler for measuring balloon diameter.
- Procedure:
- Preparation of Glucose Solutions:
  - Prepare glucose solutions of varying concentrations (e.g., $0\%, 1\%, 2\%, 5\%$) by dissolving the appropriate amount of glucose in warm water. Ensure that each solution is thoroughly mixed.
  - Label each solution accordingly.

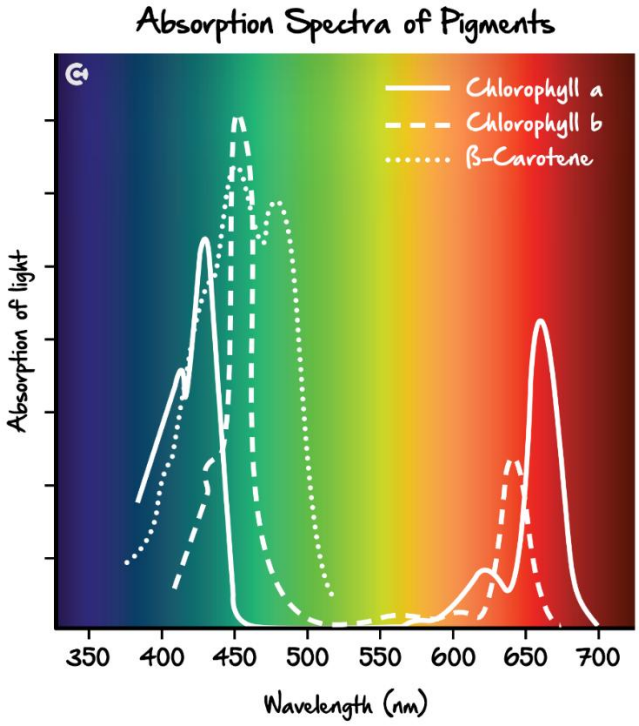
- Setup of Experimental Apparatus:
  - Inflate a balloon slightly to stretch it out, then deflate it completely.
  - Attach a funnel to the opening of each balloon.
  - Use the funnel to fill each balloon with a different glucose solution, ensuring that each balloon is filled to the same volume (e.g., halfway).
  - Carefully add a small amount of active dry yeast to each balloon through the funnel.
  - Tie off the opening of each balloon securely.
- Experiment:
  - Use a marker to mark the initial diameter of each balloon.
  - Start the timer and place all balloons in a warm, stable environment.
  - Allow the balloons to ferment for a set duration (e.g., 30 minutes to 1 hour).
- Measurement:
  - After the set fermentation period, carefully remove each balloon from the environment.
  - Measure the diameter of each balloon using a string or ruler and record the values.
  - Take care not to deflate the balloons during measurement.

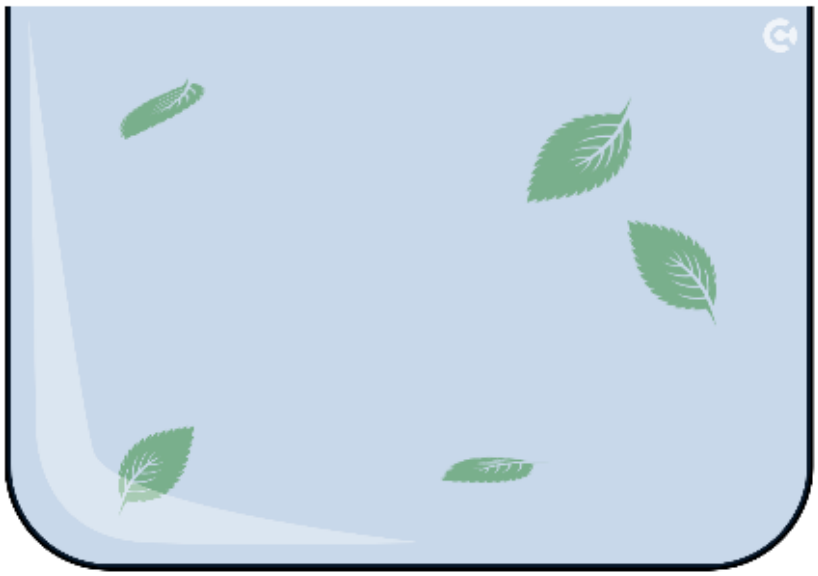


Title: Investigating the Effect of Light Colour on the Time Taken for Leaf Fragments in Coleus Plants to Rise to the Surface

- Aim:
  - To investigate how different coloured light sources impact the time it takes for leaf fragments in Coleus plants to float to the surface.
- Materials:
  - Coleus plants (with healthy leaves).
  - Shape cutter (e.g., circle).
  - Test tubes.
  - Water.
  - Light sources with coloured filters (red, blue, green).
  - Timer.
  - Ruler.
- Procedure:
- Preparation of Coleus Leaves:
  - Select healthy leaves from Coleus plants of similar size and age.
  - Use a shape cutter (e.g., heart-shaped) to cut uniform leaf fragments from the selected leaves.
  - Using a syringe, suck any air that may be present in the leaf fragment.
- Setup of Experimental Apparatus:
  - Fill six $50\ mL$ beakers with water and label them accordingly: Red light, blue light, green light, plain light, no light.
  - Place each beaker under a light source with the corresponding-coloured filter (red, blue, green).
  - Ensure that the intensity of light from each source is consistent.
  - For the "plain light" group, place a test tube under a light source without any coloured filter.
  - For the "no light" group, cover a test tube with aluminium foil to block out all light.

- Experiment:
  - Place 10 leaf fragments in each test tube filled with water, ensuring the fragments sink to the bottom of the test tube.
  - Start the timer and immediately place the test tubes under their respective light sources.
  - Observe the leaf fragments at regular intervals and record the time it takes for all 10 fragments to rise to the surface.





Question 2 (10 marks)

Experiment 1: Investigate the rate of photosynthesis in spinach leaves under varying light intensities.

a. Light intensity is generally directly correlated with another factor affecting photosynthesis. What factor is this? (1 mark)

Temperature.

b. Which tube is the negative control group? What is the purpose of the negative control group in this experiment? (2 marks)

- Group with no light.
- Has an expected outcome (the plant shouldn't grow)/hints at if there are any uncontrolled variables.

c. What is the relationship established between light intensity and the rate of photosynthesis? Why is this the case, referring to the light-dependent and light-independent stages of photosynthesis? (3 marks)

- As light intensity increases so does the rate of photosynthesis.
- This is because light is required in the light dependent stage of photosynthesis to split water and form the high energy co-enzymes, NADPH and ATP.
- The high energy co-enzymes are utilised in the light independent stage, and the unloaded co-enzymes can once again be used in the light dependent stage.

It is proposed that increasing light intensity can only be useful to a certain extent, due to two reasons.

d. At one point, the rate of photosynthesis plateaus. Explain why this may be the case. (2 marks)

- Light is no longer a limiting factor.
- Other factors become limiting e.g. CO_2 concentration.

e. At a later point, the rate of photosynthesis plummets. Explain why this may be the case. (2 marks)

- Too much light intensity = Dehydration (too much water loss) = Death
  OR
- Too much light intensity = Too high temperatures = Enzymes working outside of optimal range/potential denaturation.

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Question 3 (15 marks)

Experiment 2: Investigating the effect of glucose concentration on balloon diameter due to yeast fermentation.

a. Where is the main reaction that is being measured in this experiment occurring within the yeast cell? (1 mark)

Cytosol

b. What causes the balloons in this experiment to rise? Name any other products of fermentation. (2 marks)

- Production of carbon dioxide.
- Ethanol.

c. At the beginning of the experiment an error was made which affected the first trial group. Prior to the experiment, the lab technician filled the bottle labelled as "glucose solution" with distilled water. This error was later noticed and the results were voided. How would this have affected the results of the first trial group? (2 marks)

- No glucose → Anaerobic fermentation can't occur.
- Therefore, the balloon won't rise as no CO_2 is being released.

d. John proposes that another variation of this experiment would be "Investigating the effect of oxygen concentration on alcohol production in yeasts". Would this be a valid proposal? Why/why not? (2 marks)

- Not valid relationship.
- Alcohol can only be fermented in yeasts in the absence of oxygen.

e. What cellular processes can instead be measured in yeasts in the presence of oxygen? List an example of a way to observe this process. (2 marks)

- Cellular respiration.
- Production of CO_2, heat production.

It was noted after the data collation that the measurement of the diameter of the balloons may have been inaccurate.

f. Suggest a reason as to why this may have been the case. (1 mark)

Balloon rigidity, not measuring across the centre of the balloon every time.

g. Suggest another way such that the rate of anaerobic fermentation can be measured in this experiment. (1 mark)

Using a CO_2 electronic measurer.

h. Would this yield more accurate/precise/reliable results? Explain. (2 marks)

- More accurate results.
- Closer to its true value.

i. Active Yeasts operate optimally between 25-38 degrees Celsius. What is the purpose of using warm water, and how does it increase the validity of the experiment? (2 marks)

- Use of warm water, ensuring enzymes work optimally.
- The main limiting factor is glucose concentration - which is what we are measuring (validity).

Question 4 (14 marks)

Experiment 3: Title: Investigating the effect of light colour on leaf senescence in Coleus plants.

a. Which colour (trial group) would you expect to take the longest time to rise in this experiment? Explain. (2 marks)

- Green light.
- Least amount of light absorbed by pigments in chloroplasts.

b. Which colour (trial group) would you expect to take the shortest time to rise in this experiment? Explain. (2 marks)

- Red coloured light.
- Most absorbed by pigments - plain light isn't a colour, right?

c. Sam suggests that 20 leaf discs should be used in each trial instead of 10 - maximising the full capacity of the beaker (to the point where the leaf discs are touching against the test tube walls). Suggest one benefit of this suggestion, as well as one negative. (2 marks)

- Increased reliability/precision of results.
- Leaf's may cling onto each other - uncontrolled variable.

An alternative method of data collection is to use an ET50 time, as opposed to waiting for all the leaves to rise to the surface. The time required for 50% of the leaves to float to the surface represents the Effective Time (ET50). The rate of photosynthesis (ROP) can be calculated using the following formula:

$$\text{ROP} = \frac{1}{\text{ET50}}$$

d. Calculate the rate of photosynthesis using sample results. Express your answers as fractions. (3 marks)

	Plain light	Red light	Blue Light
ET50 (minutes)	3.2	6.5	7.2
Rate of Photosynthesis	Solution Pending	Solution Pending	Solution Pending

e. Does using the ET50 (time taken for 5 leaves to rise to the surface) improve accuracy or precision of the results obtained? Explain. (2 marks)

- Precision.
- Less likely chance that outliers will impact results.

The ET50 of the red trial group is indicative of a faster rate of photosynthesis compared to the ET50 of the blue trial group. However, using the original method of waiting until all 10 leaves had risen to the surface suggested that the use of blue light yielded a greater photosynthetic rate than red light.

f. What type of error is likely to cause this (random or systematic)? (1 mark)

Random.

g. Suggest a practical example as to how this may have happened, detailing the impact of this error on the rate of photosynthesis. (2 marks)

- Broken/old leaf.
- Enzymes not functioning as they should, rate of photosynthesis inhibited.
  OR
- Not all air sucked out of leaves - indicative of faster rate of photosynthesis than actual.

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