Assessment of B1 in the new mode of SBA biology to be implemented in S4 in 2020

New mode of SBA biology to be implemented in S4 in 2020

- Students are not required to write full procedure.
- Students are guided by specific questions to do the experimental design.
- B1 and B2 can be assessed by different experiments
- B2 remains unchanged.

Existing criteria for assessing the design and method of investigation

(i) ~~The problem under investigation is clearly identified~~. The aim of the investigation is clearly stated.

(ii) If applicable, a hypothesis is put forward in a testable form and predictions are made.

(iii) Knowledge of biological principles is applied to the design of the investigation. Where applicable, assumptions used are clearly stated.

(iv) Suitable methods, ~~techniques, including apparatus and materials~~ to be used, are stated for the investigation.

(v) The method of changing the independent variable is stated and the ways for controlling other variables are stated.

(vi) The way(s) to obtain data for the dependent variable is/are stated with due attention being paid to accuracy.

(vii) ~~The procedure shows a logical ordering of steps and is written up clearly~~.

(viii) ~~Quantities, such as volumes and times, are stated, with appropriate SI units.~~

(ix) Control set-ups and various precautions are mentioned and explained.

Revised criteria for assessing the design and method of investigation

	Basic Performance	Good Performance	Excellent Performance
Dependent variable (DV) & independent variables (IV)	1. Identify the DV and IV	9. Explain why the variables are DV and IV in the investigation	
		10. Identify multiple IV/DVs	
	2. State the methods of measurement/manipulations.	11. Explain how variables are connected with the manipulation and measurements	20. Explain the limitations of the measurement method and for the variable(s)
			21. Discuss the strengths and limitations of the alternative measurement method(s)
	3. Predict the results		
Control variables (CV)	4. Identify some CVs	12. Identify important CVs	22. Explain how some important CVs can be controlled
	5. Identify the control set-up (s)	13. Explain why the control set-up(s) (e.g. positive and negative control) is/are needed	23. Discuss the limitations of the control set-up(s)
Measurement	6. Identify important measurement errors	14. Suggest ways to reduce measurement errors / enhance reliability, e.g. repeated measurements	24. Explain why some procedures can reduce measurement errors (e.g. repeated measurement for reducing random errors; calibration for reducing systematic errors; involving one person to observe the results to reduce subjectivity)

Revised criteria for assessing the design and method of investigation

Sampling (if any)		15. Identify sampling issues / errors	25. Suggest and explain ways to reduce sampling errors (e.g. increasing sample size, random sampling)
Hypothesis (if any)	7. Identify the hypothesis tested	16. Distinguish the hypothesis from the observable predictions derived from it	26. Assess the extent the prediction gives support to the hypothesis
Assumptions (if any)			27. Identify the major significant assumptions of the design
Others		17. Explain why a specific step is conducted.	
	8. State briefly the overall experimental design and its underlying biological principle and / or concepts	18. Explain how the overall experimental design is related to underlying biological principle and / or concepts	
		19. Suggest alternative designs	28. Discuss the limitations and strengths of the alternative designs (e.g. within subject and between subject design)

Mark range	Quality of work	Performance
9-10	Excellent	The report shows most of the good performances and a few excellent performances.
6-8	Good	The report shows most of the basic performances and some good performances.
3-5	Fair	The report shows some basic performances and a few good performances.
1-2	Poor	The report shows a few basic performances.

- Teachers set assessment rubrics of a task according to the nature of the task and their students' abilities.
- The range of performances required of students should be aligned with the range of their student's abilities so that the assessment can effectively differentiate the students.
- One open question can be set at the end to allow students to respond freely.

Sample Task

Experimental question

How does the concentration of ethanol affect the membrane permeability of beetroot?

Design

The cells of beetroot have red pigment in the vacuoles. When the membranes of the vacuole and the cell membrane are damaged by ethanol, a kind of alcohol, pigment will leak out. With this information, design an experiment to answer the experimental question.

Set A- Guided questions on the experimental design

1. What are the major components of a cell membrane? Phospholipid and protein (#8)

2. Which component will be dissolved by the ethanol? Explain your answer. Phospholipid, because both ethanol and phospholipid are polar in nature. (#8)

3. What will happen if cells of beetroot are immersed in ethanol? The membrane of the beetroot cells will be damaged. (#8)

4. What is the independent variable in this experiment? Concentration of ethanol. (#1)

5. What is the dependent variable of this experiment? How do you measure it? Permeability of cell membrane (#1). We can measure the colour intensity of the bathing solution after immersing the beetroot tissue into the ethanol (#2), the higher the intensity of the colour, the higher the permeability (#3)

6. State at least two controlled variables of this experiment to make it a fair test. Volume of ethanol, surface area of the beetroot tissue, time for immersion (#12) Temperature of the environment, addition of beetroot tissue at the same time (#4)

7. What assumptions should you make in this experiment to make the results valid? The colour intensity of the bathing solution is proportional to the permeability of membrane (#27)

8. Are there any other concerns or considerations that you can think of to improve the design? (open-ended to allow reaching of other good / excellence performance)

Set B- Guided questions on the experimental design

1. In this experiment, we are investigating how a factor (**independent variable, IV**) affects another factor (**dependent variable, DV**). What are the DV and IV of this experiment? IV is the concentration of ethanol. DV is the membrane permeability. (#1)
2. Explain how the membrane permeability of the beetroot cells can be measured based on the above information. Suggest an accurate and reliable method for the measurement. The membrane permeability can be measured by the amount of red pigment leaked out of the vacuoles. The amount of red pigment can be estimated from the intensity of red colour as judged by eyes or more accurately by colorimeter. (#11)
3. What do you predict the results when beetroot tissues are put into different concentrations of ethanol? The higher the concentration of the ethanol, the more the membrane is damaged. More red pigment will leak out from the vacuoles, producing darker red colour at higher ethanol concentrations. (#3)
4. Will you (1) put the **same** beetroot into different concentrations of ethanol **one after one**, or, (2) put **different** beetroot into different concentrations of ethanol? Discuss the strengths and drawbacks of each design. Design (1) has the problem that the membrane of beetroot has been damaged by the previous treatment of the ethanol and some red pigment has leaked out. It thus cannot show the effect of a concentration of ethanol. Design (2) avoids this problem, but the beetroot put into different concentrations of ethanol may be different, e.g. cells containing different amount of red pigment. It makes the comparison between different treatments unfair. (#28)
5. Your teacher stresses that the beetroot has to be cut into same size and shape in each concentration of ethanol. Explain why it is needed. The shape and size of beetroot affect its surface area in contact with the ethanol. The one with larger surface area will have faster leakage of pigment. It makes the comparison between different treatments unfair. (#22)

Set B- Guided questions on the experimental design

6. One student proposes putting a **3 cm cylinder** of beetroot into each concentration of ethanol. Another student thinks the cylinder should be cut into **three 1-cm discs** to be put into each concentration of ethanol. Which one do you think is better? Explain why. It is better to cut the beetroot into smaller discs. It increases the surface area and speeds up the leakage of pigment. This would shorten the time needed for the experiment and produce more obvious results for comparison between the treatments. (#17)

7. Apart from ethanol and the shape and size of beetroot, are there other factors that may affect the leakage of pigment from beetroot cells? Explain your answers. How can these factors be controlled?

The longer the beetroot is immersed in the ethanol, the more the membrane is damaged and the more pigment is leaked out. It can be controlled by keeping the time of immersion the same for each treatment. (#22). There may be varying amounts of red pigment in the vacuoles of different beetroot cells. The cells with higher pigment concentration will leak out more pigment. This variation can be reduced by using the same beetroot, and by **randomly** putting the beetroot discs into different concentrations of ethanol. (#22)

8. Do you think the **volume** of ethanol (not the concentration) bathing the beetroot needs to be kept the same for each treatment? Explain your answer. The **volume** of ethanol needs to be kept the same for each treatment because it will affect the colour intensity observed. A larger volume, however, would **not** make greater damage to the membrane and more leakage of pigment. (#22)

9. What is the **major assumption** underlying the whole experimental design? (An assumption is something we think it is true, though we cannot be sure. A major assumption is the one that the experiment cannot make any conclusion without assuming it to be true). Membrane permeability of beetroot is proportional to the amount of pigment leaked out from

Procedure to be handed out to students after completing the design.

Materials

Ethanol (15%, 30%, 50%) each 1 tube 2. Beetroot 1 pc 3. Razor blade 1 pc 4. Plastic chopping board 1 pc 5. Test-tube 4 pcs 6. Test-tube rack 1 pc 7. Stopper 4 pcs 8. Measuring cylinder (10 ml) 1 pc 9. Labels 4 pcs 10. Forceps 1 pc 11. Cork borer 1 pc 12. Beaker (250 ml) 1 pc 13. White paper 1 pc On side bench: (for the whole class) 13. Distilled water (in wash bottle)

Procedure

1. Transfer 10 ml of distilled water, 15%, 30% and 50% of ethanol into each of 4 test tubes respectively. Label the tubes.
2. Using the same beetroot, prepare 4 cylinders of beetroot, each of 2 cm long, using cork borer and razor. Cut the cylinder of beetroot into four discs of the same thickness.
3. Rinse the cylinders of beetroot in running tap water until no pigment comes out from the damaged cells.
4. Randomly put 4 discs of beetroot into each of the test tubes prepared in step 1. Stopper the tubes.
5. Leave the tubes for 20 minutes. For every 5 minutes, shake the tube gently for a few seconds.
6. Take the cylinders of beetroot out from the test tubes using a pair of forceps.
7. Place the test tubes in front of a white paper. Record and compare the intensity of red colour of the solutions in the tubes with naked eyes.

Ways of implementation

B1 Experimental design (assessment or T&L)

Procedure given to conduct experiments (assessment of A or not)

B2 - Discussion of data and drawing conclusion

The assessment of B2 will remain unchanged.