Victoria Junior College
Biology Department
2021 Prelim Paper 4 Suggested Answer

Marking abbreviations:
A: Accept R: Reject BOD: benefit of doubt AW: alternative wording AVP: Any valid point
NAQ: not answering question

Question 1

(a) (i) Suggest why betalain molecules cannot pass from vacuoles of plant cells into the cytoplasm. [2]

1. betalain molecules are polar / charged / hydrophilic;
2. (so) will not be able to diffuse through hydrophobic core of phospholipid bilayer or hydrophobic 'tails' of phospholipids;
3. membrane lack membrane proteins / carriers / channels / pumps to transport betalain across membrane;
   Or
4. betalain molecules are too large;
5. (so) will not be able to diffuse, through hydrophobic core of phospholipid bilayer / AW ;
   A ref. to hydrophobic 'tails' of phospholipids

Note: mark will only be awarded once for either points 1 or 4. The second mark is awarded for the explanation which must be related to the first point (i.e. point 1 or 4) that student gave.

(ii) Why were beetroot discs washed several times before they were used? [1]

- The surface of the beetroot discs is covered by pigments and hence affecting the accuracy of the data collected;
  Or
- Wash away the leaked pigments from cut/ damaged cells so that the leakage of pigment later can be attributed to the effects of alcohol;

(iii) State the concentrations of alcohol that you will use in your investigation. [1]

- at least five different concentrations of alcohol at regular intervals, including 0%
  e.g. 0, 20, 40, 60, 80, 100% / 0, 25, 50, 75, 100%

  R: 10x, 5x, 2x dilution factors, i.e., serial dilution

(iv) Use the space provided below to show, in a suitable format, how you prepared the solutions of alcohol. [4]

Concentration of alcohol/ %	Volume of **100%** alcohol / cm^3		Volume of distilled water / cm^3		Total volume / cm^3	
0	0.0	0.0	10.0	5.0	10.0	5.0
20	2.0	1.0	8.0	4.0	10.0	5.0
40	4.0	2.0	6.0	3.0	10.0	5.0
60	6.0	3.0	4.0	2.0	10.0	5.0
80	8.0	4.0	2.0	1.0	10.0	5.0
100	10.0	5.0	0.0	0.0	10.0	5.0

Marking points:
1. A complete lined table, with independent variable on left-most column;
2. Correct column headings with appropriate units + No units in the body of the table;
3. [Precision] Recording of volume;
4. [Calculation] Correct calculation;

Allow error from (iii) carried forward (ECF) here. Calculation is based on the alcohol concentration indicated.

(v) State and explain a step that you can take in the preparation of the discs to ensure that you obtained valid results in this investigation. [2]

- step taken on preparing discs, e.g. use a cutter with a fixed dimension of 4 mm / measure and discard poorly cut discs;
  ignore simple use of ruler and scalpel
- to ensure constant thickness/ surface area of discs;

OR

- discs washed, until no trace of pigment / same number of times (minimum of four) or discs handled carefully so not, punctured / damaged;
- ensuring no further leakage of pigment / explanation involving cell damage;

OR

- cut the discs from the same core of beetroot tissue/ select discs with the same colour throughout;
- to ensure that beetroot discs have the same concentration of betalain at the start of the experiment;

(vi) Use this space to record, in a suitable format, your results from step **6**. [4]

Concentration of alcohol/ %	Concentration of betalain/ %
0	0.0
20	Between 0.0 and 0.1
40	0.5
60	Between 1.0 and 5.0
80	5.0
100	Between 5.0 and 10.0

Another possibility:

Concentration of alcohol/ %	Concentration of betalain/ %
0	0.0
25	Between 0.5 and 1.0
50	Between 1.0 and 5.0
75	Between 1.0 and 5.0
100	Between 1.0 and 5.0

Marking points:
1. A complete lined table, with independent variable on left-most column;
2. Correct column headings with appropriate units + No units in the body of the table;
3. [Precision] Recording of percentage concentration of betalain according to prepared solutions, no intermediate values (accept middle value, i.e., 0.05, 0.3, 0.75, 3.0, 7.5 only);

4. [Accuracy] 0% alcohol is not more than 0.1% betalain, 100% alcohol is between but not including 1 and 10% betalain and correct trend of having increasing concentration of betalain / accept plateau seen above 50% alcohol;

(vii) Describe **and** explain your results. [3]

1. As concentration of alcohol increases from 0 to 100%, concentration of betalain increases from 0 to between 5.0 and 10.0% ;
2. alcohol dissolves / disrupts hydrophobic region / fatty acids / (phospho)lipid 'tails' of cell membranes / tonoplasts and cell (surface) membranes;
3. permeability of cell membranes to betalains increases with alcohol concentration
   OR betalains diffuse, out of vacuoles and cells / through tonoplasts and cell (surface) membranes;
4. any plausible suggestion as to type of disruption e.g. pore formation / disruption of organisation /denaturation, of proteins in membranes;
5. membrane remains intact up to critical concentration (for those students with plateau);

(viii) Based on the **apparatus** and materials **provided**, explain how you would increase the confidence in your estimation for 100% alcohol. [2]

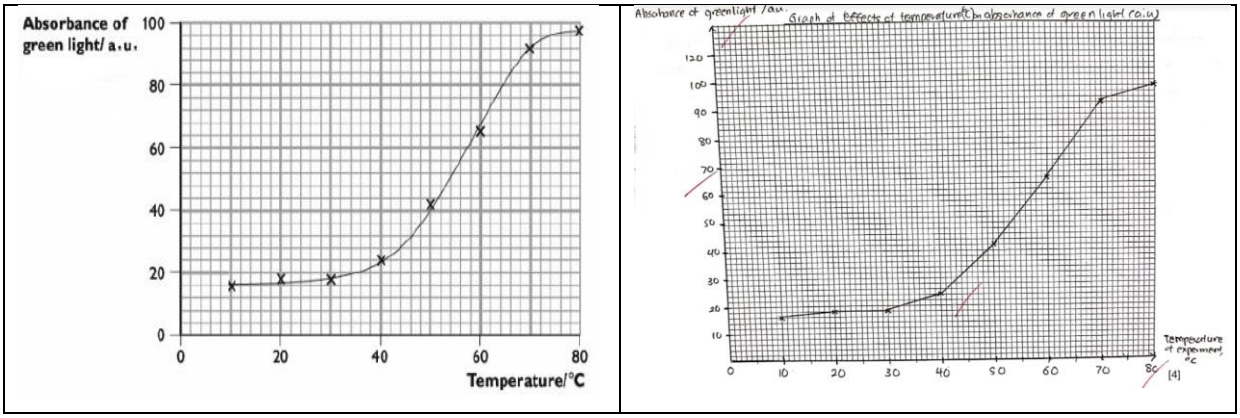
1. prepare further concentrations of betalain of regular intervals between 5.0% and 10.0% e.g. 6.0, 7.0, 8.0%, 9.0 to better determine the actual concentration of betalains for 100% alcohol;
   A: based on student's results
2. place the tube for 100% alcohol against these standard solutions of betalain for colour matching against the white card;

(ix) Describe and explain a suitable control for this investigation. [2]

1. 5 cm^3 0% alcohol / distilled water with the 2 discs immersed for 20 minutes;
   A: 2 glass beads / no beetroot discs in alcohol solutions for 20 minutes
2. so that any leakage in water needs to be taken into account when interpreting results from the alcohol solutions / to show that the permeability of membranes is due to the presence of alcohol;
   A: to show that the colour of the solutions is due to the effect of alcohol on the permeability of the membranes

(b) This procedure can be modified to investigate other factors which influence the permeability of membranes.

(i) Use the grid opposite to present your results in a suitable format. [4]



Marking points:

1. (A) Axis – labelled with correct units;
2. (S) Scale – graph should occupy at least two-third of the area of the total grid with no odd scale;
3. (P) Points – plotted accurately;
4. (L) Line – point-to-point OR best fit. No extrapolation of graph.

(ii) With reference to the graph, explain the effect of temperature on the absorbance of light in the colorimeter. [3]

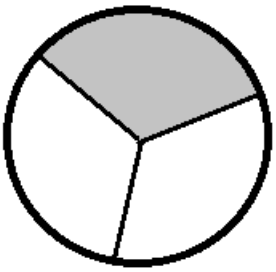
1. (QV) As temperature increases from 10°C to 80°C, absorbance of green light increases from 16a.u. to 98a.u;
2. Ref <u>increasing kinetic energy</u> of molecules (phospholipids & proteins) which move faster, <u>creating gaps / pores</u> in the membrane;
3. Ref protein molecules denaturing at high temperatures because their hydrogen/ ionic bonds break, OR idea of high temperature disrupting hydrophobic interactions between phospholipids creating pores in membranes;
4. Idea of kinetic energy of molecules increases which increases movement of pigment molecules diffusing across the membrane;

Question 2

(a) (i) The stem shows regular patterns in the overall shape as well as distribution of vascular bundles.

Use Fig. 2.1 as a guide, draw a large, representative plan diagram of one third of the stem.

Use one ruled line and label to identify the xylem.



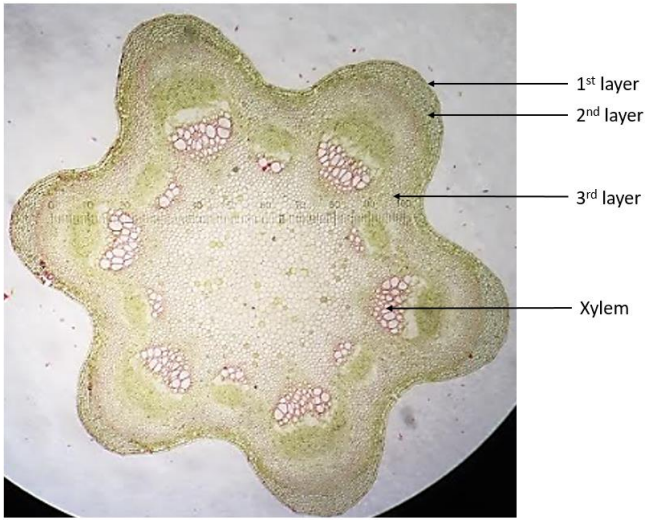
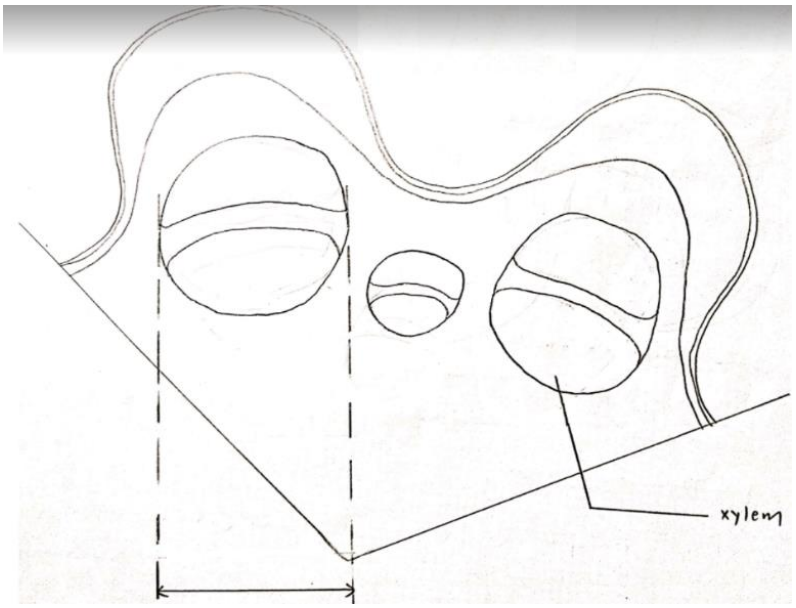


Fig. 2.1



Marking points:

1. Neat, continuous lines with no shading. Drawing shows only 1/3 of the specimen (as instructed).
2. Correct number of layers (3) + correct proportion / relative thickness of layers
3. Correct shape and sizes of vascular bundles (must show difference in sizes between the vascular bundles)
4. Ruled line to identify xylem

(ii) You are provided with a plastic ruler and an eyepiece graticule that is attached to the microscope. Determine the length of the largest vascular bundle in the specimen on slide **TTI**.
Show your working clearly. [3]

1. State objective lens used / viewing magnification AND correspond number of eyepiece divisions to ruler divisions;
2. Correct calculations to show length of 1 eyepiece division;
3. Correct number of eyepiece divisions corresponding to largest vascular bundle and correct calculation of its length;

Accepted for 40x or 100x magnification

Sample answers:

- Under 4x objectives lens / Under 40x magnification, 100 eye-piece divisions = 2.5 mm;
- 1 eyepiece division = 25µm;
- Length of vascular bundle = (accept range of 20 - 30) eyepiece divisions = ~500 – 750µm;

OR

- Under 10x objectives lens / Under 100x magnification, 100 eye-piece divisions = 1mm;
- 1 eyepiece division = 10µm;
- Length of vascular bundle = (accept range of 55 - 70) eyepiece divisions = ~550 – 650µm;

(iii) Use your answer in **(a) (ii)** to calculate the magnification of your drawing in **(a) (i)**.

Show your working clearly. [2]

1. Annotated length of vascular bundle in drawing OR stated length of vascular bundle clearly in working;
2. Correct calculation of magnification based on formula of drawing size / actual size; Accept ECF based on value of actual size from (a) (ii);

(iv) Explain **why** the use of the plastic ruler for calibration is less accurate compared to the use of a stage micrometer. [2]

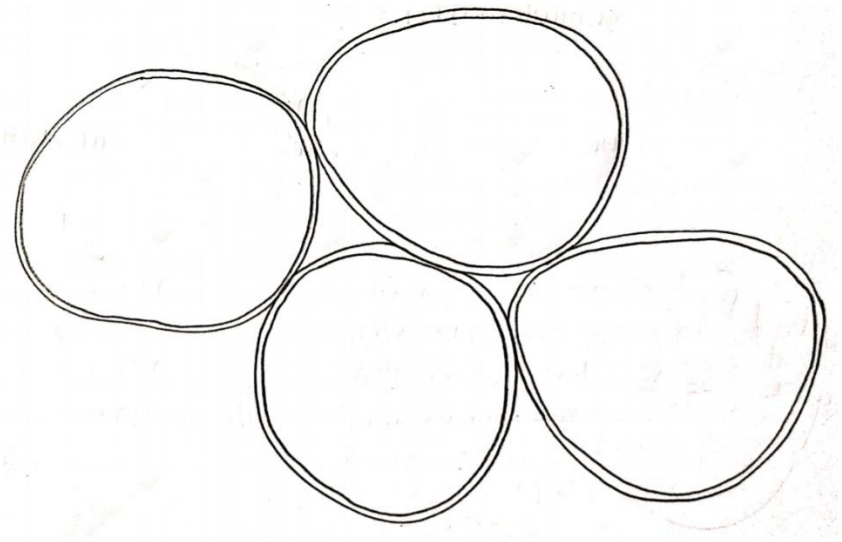
1. Larger divisions on ruler of 1mm vs smaller divisions on stage micrometer of 0.01mm;
2. Idea of less precision based on greater uncertainty in the rulers used;
   OR
3. Thicker lines on the divisions of ruler vs thinner lines on divisions of stage micrometer;
4. Idea of difficulty in aligning the eyepiece graticule with the ruler for calibration as several eyepiece graticule units overlap one marking on the ruler OR difficulty in deciding where to start and end the reading of the eyepiece graticule;

(v) Observe the cells in the central region of the stem section on **TTI**.

Select one group of **four** adjacent cells that show some of the observable features of the central tissue.

Each cell must touch at least two of the other cells.

Make a large drawing of this group of **four** cells. [3]



Marking points:

1. Neat, continuous lines with no shading. Drawing shows only 4 cells, with each cell touching 2 other cells (as instructed).
2. Correct shape and size of cells (cell sizes are similar to each other)
3. Presence of intercellular air spaces & consistency in cell wall thickness;

(vi) Complete the table below to describe two observable differences between the cells you have drawn and the xylem vessels in the slide. [2]

Cells drawn in (v)	**Xylem vessels**
Thinner cell wall	Thicker cell wall
Presence of intercellular air spaces	Absence of intercellular air spaces
Round shape	More angular shape

(b) (i) Present your results in a suitable format in the space below. [4]

Concentration of ascorbic acid / $mgcm^{-3}$	Number of drops of **ascorbic acid** used to decolourise DCPIP		
	R1	R2	Average
4.0			
2.0			
1.0			
0.5			
Plant extract, C			

R1, R2 : repeats of experiment

Marking points:
1. Independent variable as first column - C must be included in the first column;
2. Correct column headings with appropriate units;
3. Correct trend AND accuracy- with 4.0 $mgcm^{-3}$ having a range of 6-10 drops AND correct increasing number of drops as ascorbic acid concentration decreases;
4. Data: 2 sets of data AND average AND correct precision for average

(ii) Based on your results in step **4** estimate the concentration of ascorbic acid in the plant extract **C**.

Concentration of ascorbic acid in **C**: …… [1]

- Results based on **closest estimate** in table correct to 1dp
  Accept value: 0.5/1.0/0.75 $mgcm^{-3}$

(iii) Identify the most significant source of error in the experimental procedure and suggest an improvement.

Source of error	Improvement
Recording in number of drops because each drop may not be of the same volume;	Use syringe to record volume of ascorbic acid instead of number of drops; R: using a micropipette/ Pasteur pipette/dropper as it will still be dropwise
Difficult to determine the endpoint of decolourisation/ subjectivity;	Use a colorimeter to (measure the absorbance so as to) determine the decolorisation/end point;

[2]

(c) A student observed that the ascorbic acid found naturally in plants could also reduce the copper ions in Benedict's solution to produce a positive result.

You are now required to plan an investigation to estimate the quantity of reducing sugars present in the plant extract **C**.

Based on the information provided in **(b)**, describe a method that you can use to estimate, as accurately as possible, the concentration of reducing sugars **only** in the plant extract **C**. Do not plan for controls and repeats.

You are provided with the following reagents:

- Plant extract **C**
- Benedict's solution
- Distilled water
- 1M glucose solution
- DCPIP

Your planned method should:

- have a clear and helpful structure so that the method described could be repeated by anyone reading it
- include details to ensure that results are as accurate and repeatable as possible
- only make use of the reagents provided

[4]

Marking points:

1. Describe dilution of 1M glucose into at least 5 different concentrations to act as glucose standards;

2. [MUST have] Addition of fixed volume /number of drops of DCPIP to react with ascorbic acid;
   Reject: dropping C into 2 cm^3 of DCPIP and then carry out Benedict's test as the total volume of C used will be different from the standard.

3. Same volume used for C and glucose standards;

4. Addition of fixed volume of Benedicts' solution + use of boiling water bath;

5. Either record and compare changes in colour and clarity and find the concentration that has the closest match to colour and clarity of C; Or
   Or note the time taken for the first colour change for all glucose concentration and C. The one with the closest timing to C has the same reducing sugars as C;