And Remember Kids

1. If anything said here contradicts what your teachers or tutors told you, prioritise them.
2. Stay calm and read the question carefully, don't assume you know whats gg on just because the apparatus is familiar
3. You're not special, Cambridge is not going to set a specially difficult paper for you
4. Plot your graph points correctly!!! Losing 1 mark for being 1 square off is throwing!!!.
5. You have plenty of time so don't stress if you're stuck js move on
6. If there is an abnormal question you may find comfort in knowing that everyone else will be just as confused as you will be.

Microscopy

1. Comparison Questions

Generally for microscopy, compare arrangement, shape and size of cells (triangular / rectangular / oblong / oval)

You can compare the presence of starch granules / vacuoles / choloplast but I wouldn't recommend it bcos you can't really tell the difference between them under a microscope and it may not be a valid marking point in answer scheme, unless it's a last resort.

Dicots VS Monocots

Diameter

- Dicots are larger and Monocots are smaller

Vascular Bundles (ie Xylem and Phloem)

- Arrangement: Dicot's are arranged in a ring around the central pith, Monocot's are clustered at the root
- Number: Dicot's are limited in number, Monocot's are numerous
- Shape: Dicot's are uniform and larger in size. Monocot's tend to have larger VB present towards the center and smaller VB at the peripherals

Pith (central mass of cell)

- Well developed in Dicots, reduced and remains undifferentiated in Monocots

Cortex

- Cortex area relative to root is larger in Dicots and smaller in Monocots

Endodermis (tissue layer that circles the vascular bundles)

- Present in Dicots, absent in Monocots

Number of tissue layers

- Dicots have more as the cells are more differentiated and hence have more distinct organisation

Other Possible Comparisons

- Presence of ___ (hair, idk)
- Overall shape of ___
- Thickness of ___

2. Limitations / Improvements in microscopy

- Measure all the __(eg vascular bundles)__
- Larger magnification, easier to measure

- Take more sections

3. Scale and Magnification

Calibration (micrometre)
cm = 10
mm = 10^{-3}
µm (micrometer) = 10^{-6}
nm (nanometer) = 10^{-9}

4x ≡ 25um
10x ≡ 10um
40x ≡ 2.5um

20 eyepiece graticule units = 1 division on stage micrometer = 1×0.05 mm
1 eyepiece graticule units = 0.05/20 = 0.0025mm = 2.5um (1dp)

Calculating length of specimen
Count no. of eyepiece divisions of the specimen.
Convert to um (10^{-6}) (2sf **NOT 3sf**)
Calculating Magnification
Magnification = (length of drawing) / (length of specimen)= x(2sf) **NOT 3sf**

4. Drawing (weird specimens in Annex A)

- Clean Continuous Lines, no fuzzy / half erased lines
- Scale, at least ¾ of given space, better to draw too big than too small
- Proportion (cell wall shld be ⅛ of the radius of the cell)
- Details, tissue layers, organelles etc.
- Label (if required)

Do a little sketch as you're looking through the microscope before drawing the real thing.

Don't hard memorise monocot/dicot diagrams, **draw what you see.**

Cambridge is quite harsh on shape and proportion, be sensitive to the shapes.

If given a specific observation boundary, **do not draw the boundary**. The boundary does not exist on the actual specimen.

Experiments

Commonly tested topics

- Respiration / Photosynthesis of Yeast or Plants (use of DCPIP / hydrogencarbonate indicator / MnO4 / Colourimeter / Number of bubbles / Gas Collection in syringe)
- Enzymes (comp vs non-comp, amylase and starch, fruit enzyme)
- Water potential (visking tubing, potatoes, diffusion of something)
- Heat loss / Heat gain
- Food tests (Benedict's test)
- Bacteria (agar plates, culture)
- Molecular Techniques (mainly planning, match parent with child)

Specific stuff and what to link them to

- Calcium Chloride / Sodium Alginate solution (make balls of leaf extract / yeast)
- Yeast suspension (must always be in a pH buffer!)
- Delivery Tube (gas collection)
- Lamp (photosynthesis)
- Agar Plate (diameter of colour change / growth of something)
- Scalpel and White Tile (Cutting vegetables)
- Fruits and Vegetables (water potential, starch test, benedict's test, extract enzyme)

1. Tables

Tables are giveaway marks do not throw them :C

Multiplication = smallest sf
Addition = smallest dp

Simple Dilution: either question will give you the factor to dilute by or come up with your own
Serial Dilution: Multiples of 2 or 5 only. If you're having trouble perhaps qn wants you to do simple dilution instead.

Always write in full, table should have enough info to stand on its own.

(IV) Sample	*(DV)* Mean time taken for colour to turn **from red to blue** (trial 1+2/2) /min
A	
B	

> Mean Time (Trial 1+2/2) /s
> Rate of respiration (1/mean time) /s^{-1}

Replicate readings = calculate mean, not average eg Mean [(Trial 1 + Trial 2) / 2] / cm^3

I always put the conversion in brackets, I'm not sure if its mandatory but just to be safe

Cambridge Guidelines

1. Colour – *before and after*, not just final colour

Sample	Colour change of tube content
A	**Colourless** to **Purple**

2. ~~Average~~ Mean
3. if there is anomaly in data, exclude it from mean calculation, denote the data with [A]

So long as your data is consistent with your conclusion, ECF will be given.

2. Sources of Error / Limitations / Improvements

As you're doing the experiment, note the possible improvements to be made.
This list is from easiest to hardest to spot (in my opinion).
Control is NOT AN IMPROVEMENT OR A LIMITATION

Error / Limitation	Improvement
Accuracy/Reliability	**Averaging** replicate readings of.. **Repeat** the entire experiment to obtain another set of data
	Smaller intervals of …
	Use a **syringe**/**pipette** to measure..
Difficulty of determining end point (colour, whether a bead has fully floated/sunk)	Use **colour standard** for comparison of end-point / **Colourimeter** / CO_2 Data Logger / pH meter / Resepirometer (measures rate of change of O_2 and CO_2)
Temperature of __ not standardised / Temperature fluctuates Temperature (of two different solutions added together) were not at the same temperature	**Thermostatically controlled water bath** to ensure constant temperature **Acclimitise** (solution) in thermostatically controlled water bath to ensure both solutions are at the same temperature.
Inconsistent duration of each experiment (eg leaving beads in pH buffer while one is conducting experiments, hence the beads used will be exposed to pH buffer with different durations)	**Stagger starting time** e.g 1min interval
Uneven size of beads / Difficulty determining size of beads	-
Delay in putting bung into boiling tubes, some CO2 can escape.	-
Not enough intervals / intervals are estimated such that it overshoot/undershoot the unknown to test for	Smaller intervals / More intervals
Visual determination of amount of ppt is subjective	Weigh its dry mass using weighing scale
Leaf disc worse than Leaf Beads	Discs have diff stomata density and may have air spaces in them —> interfere with ability of the disc to float Some leaves might be too small to be cut by a (insert tool)

3. Other Question Types

Controls
Replace ___ ***with boiled and cooled ___ / DI water of equal volume / glass beads***, keeping ***all other factors constant.***

How will variables be kept constant
- State the variable
- State the method (thermostatically controlled water bath, heat filter, pH meter, colour standard etc.)

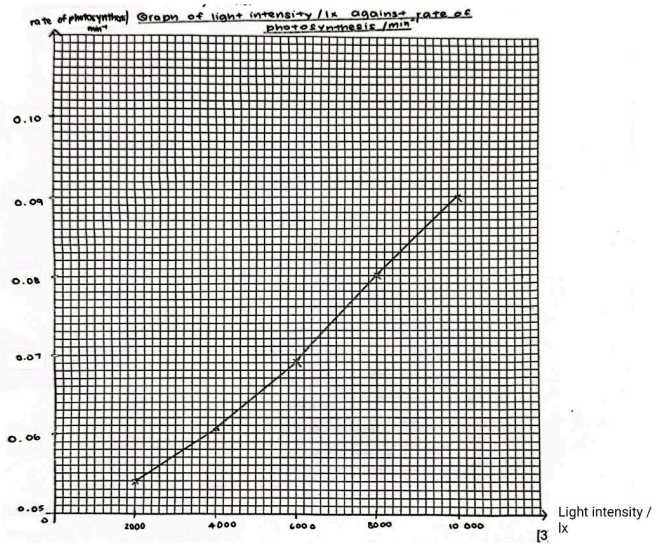
Describe a method and show assessment of degree of confidence / risks
1. Describe method (be as detailed as possible, apparatus, how to vary sample interval)
2. Repeat, find mean
3. Convert (if needed)
4. Risks (if needed)

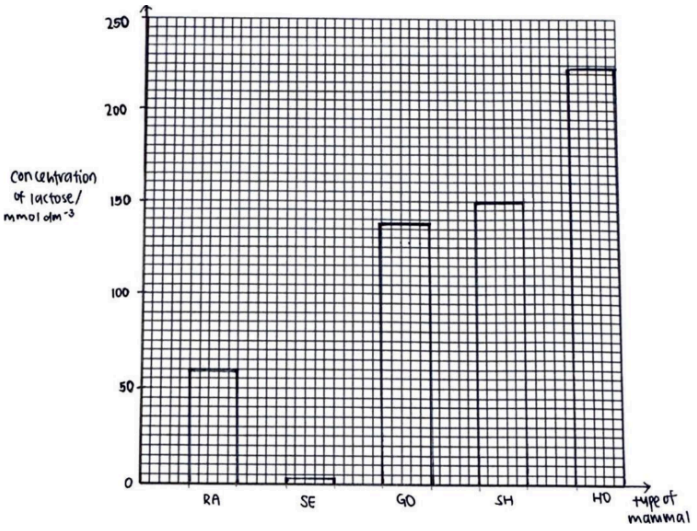
Data Processing

1. Given data, plot graph

Bar Graphs (IV is not continuous)
- Don't need to shade

Line Graphs (IV is continuous)
- ***Dot-to-dot*** if the question doesn't specify. If later asked to calculate gradient usually both dot-to-dot and best fit will be accepted.
- Best Fit Line = Line/Curve
- DO NOT EXTRAPOLATE unless asked to.





2. Given data, perform T-test

How is the data suitable for performing T-test?

- Data is continuous
- There is a mean for each set of data
- Data follows a normal distribution curve

Remember to **show your calculation for Degrees of Freedom**! Don't do it in your head and just write the final answer (-1 mark) booooo

a. Steps for Conducting T-Test

Step 1: State the null hypothesis and alternate hypothesis

H_0: There is no significant difference between the mean of the two samples. Any differences may be due to chance or sampling error.

$$H_o: \mu_1 = \mu_2$$

Determine the type of t-test to be carried out and hence the H_1.

Two-tailed t-test	The mean of sample 1 is not equal to the mean of sample 2. $H_1: \mu_1 \neq \mu_2$
Upper-tailed t-test	The mean of sample 1 is larger than the mean of sample 2. $H_1: \mu_1 > \mu_2$
Lower-tailed t-test	The mean of sample 1 is larger than the mean of sample 2. $H_1: \mu_1 < \mu_2$

Step 2: Calculate t value and degrees of freedom

$$t = \frac{|\bar{x}_1 - \bar{x}_2|}{\sqrt{\frac{{s_1}^2}{n_1} + \frac{{s_2}^2}{n_2}}} \qquad v = (n_1 + n_2) - 2$$

where
$\bar{x}_1, \bar{x}_2$ are the sample means of sample 1 and 2 respectively
s_1, s_2 are the standard deviations of sample 1 and 2 respectively
n_1, n_2 are the sample sizes of sample 1 and sample 2 respectively
v = degrees of freedom

Step 3: Identify critical t value and compare it with the calculated t value

Using 0.05 level of significance and the degrees of freedom, determine the critical t value from the table of t values (Figure 4).

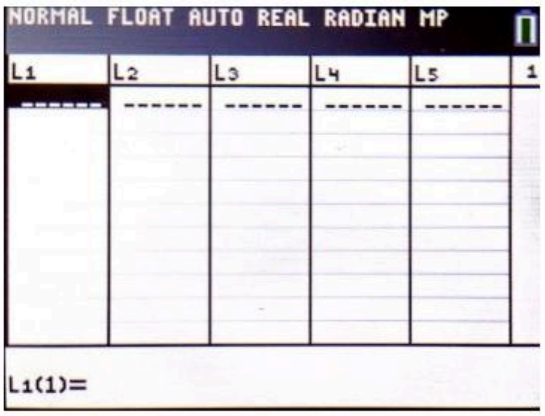
Compare calculated t and critical t values:

- At 0.05 level of significance, if |calculated t| < critical t, do not reject H_0. Conclude that the difference between the two samples is not significant and any difference is due to chance or sampling error.
- At 0.05 level of significance, if |calculated t| > critical t, reject H_0 and conclude that the difference between the two samples is significant and any difference is not due to chance or sampling error.

b. Using Graphic Calculator

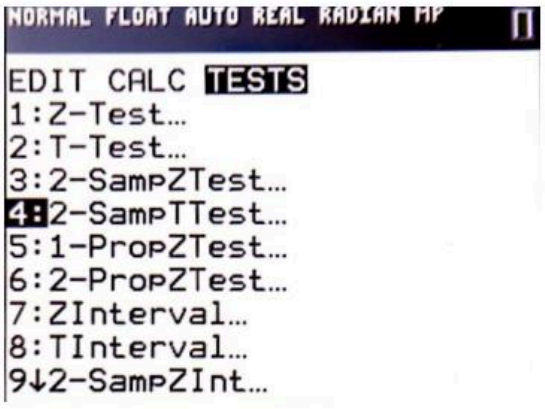
Step 1: Key in raw data into lists:

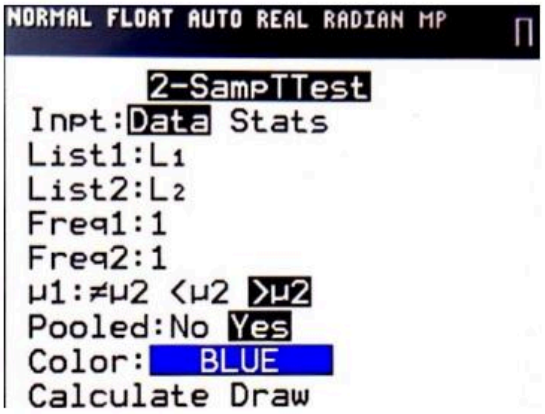
- Press STAT
- Under EDIT select "Edit…"
- Enter values for sample 1 into L_1 and values for sample 2 (control) into L_2



Step 2: To conduct t-test:

- Press STAT
- Click on right arrow twice to go to the TESTS menu
- Press 4 for "2-SampTTest"
- Input data as follows:
  - List1: L_1
  - List2: L_2
  - μ1: ≠μ2 <μ2 >μ2 (Select the relevant option depending on the type of t-test)
  - Pooled: No **Yes** (Select Yes – FYI this assumes that variance of two samples are the same)
- Select "Calculate" and enter, you will then see the following results:
  - t is the calculated t value
  - p is the p value
  - $\bar{x}_1, \bar{x}_2$ are the sample means of sample 1 and 2 respectively
  - s_{x1}, s_{x2} are the standard deviations of sample 1 and 2 respectively





(Example for upper-tailed T test)

In the GC, you can compare the p-value (observed level of significance) to the set 0.05 level of significance. If p-value < 0.05, reject H_0 , if p-value > 0.05, do not reject H_0.

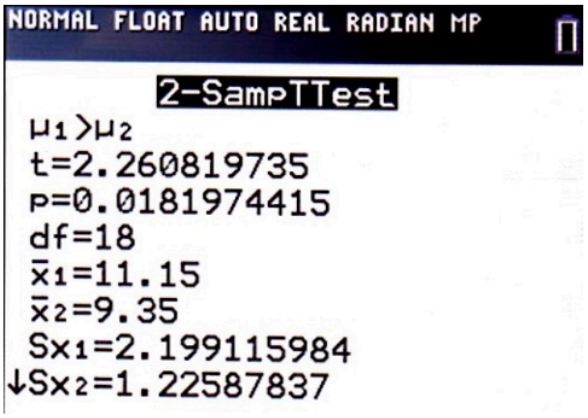
Solution:

μ_1 represents the population mean of the increase in height of plants grown with fertilisers
μ_2 represents the population mean of the increase in height of plants grown without fertilisers

$H_0: \mu_1 = \mu_2$ $H_1: \mu_1 > \mu_2$

Using GC,
$\bar{x}_1 = 11.15$ $\bar{x}_2 = 9.35$
$s_1 = 2.1991$ $s_2 = 1.2259$

$$t = \frac{|11.15 - 9.35|}{\sqrt{\frac{2.1991^2}{10} + \frac{1.2259^2}{10}}} = 2.26\ (3\ s.f.)$$



Degrees of freedom = (10 + 10) – 2 = 18

From the T table,
At p = 0.95, critical T value is 1.734
Calculated T = 2.26 > critical T 1.734

OR From GC, p-value = 0.0182 < 0.05

We reject H_0 and conclude that there is sufficient evidence at the 5 % significance level to claim that fertilisers increase the growth of soybean plants.

T-Test Summary
$|T_{calc}| \geq T_{crit}$, reject H_0.
$|T_{calc}| < T_{crit}$, do not reject H_0. ('accepting' H_1 is scientifically inaccurate phrasing)

p_{calc} / corresponding p value of $T_{calc} \leq 0.05$, reject H_0.
p_{calc} / corresponding p value of $T_{calc} > 0.05$, do not reject H_0.

Null Hypothesis
There is **no significant difference** between the **mean** of __ and __
Any **difference is due to experimental error or chance.**

Conclusion
We **(do not) reject the null hypothesis.** There is **(in)sufficient evidence at the 5% significance level to claim that** __

Planning
This is either really simple or a big wild card. Either way don't stress and just read.

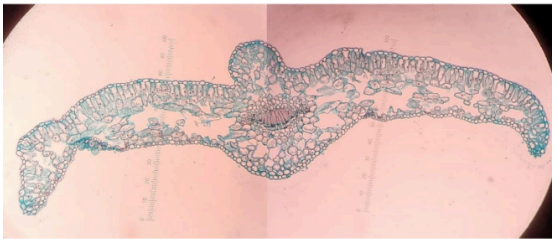
1. Draw a plan for your experiment so that you know what the qn wants you to do
2. Note the things to **acclimitise / equilibrate** eg **calibration** and setup of certain apparatus till equilibrium eg respirometer in 10℃ environment
3. Note the solids / potatoes you need to weigh
4. Qn say must use means must use no buts
5. Note solutions that need simple / serial dilution
6. Repeat, mean, safety concerns
    a. Corrosive / Irritants like acids, enzyme solutions etc., wear gloves to avoid contact with skin and wear goggles to avoid contact with eyes
    b. Scalpel: Wear gloves to avoid cuts
    c. Electronics: Ensure experiment is done in a dry environment to avoid electrocution
    d. Heat (eg lamp, bunsen burner, hot water): Wear gloves to avoid burns, wear goggles to avoid contact with eyes

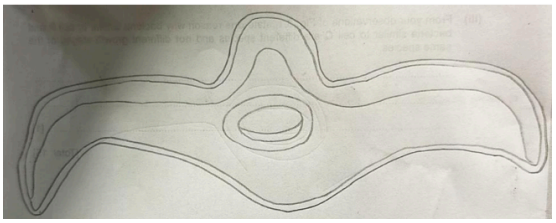
Your plan should…
Scientific backing / justification / explanation – Theory ✅
Recording of / Proposed results – Tables and graphs ✅

Theory, Variables, Hypothesis ★ Theory (1 para) ★ Independent variable and Dependent variable **must be measurable.** concentration of milk ✅ amount of water added to milk ❌ distance between lamp and plant ✅ light intensity ❌ ★ Controlled variables (at least 2)	**Method** ★ Sequencing of steps ★ Apparatus ★ Control ★ Repeats ★ Relevant tables (eg simple dilution) Volume of test tube = 20.0 cm^3 Volume of boiling tube = 40.0 cm^3
Results ★ Table/Graph	**Safety** ★ Risk ★ Precaution

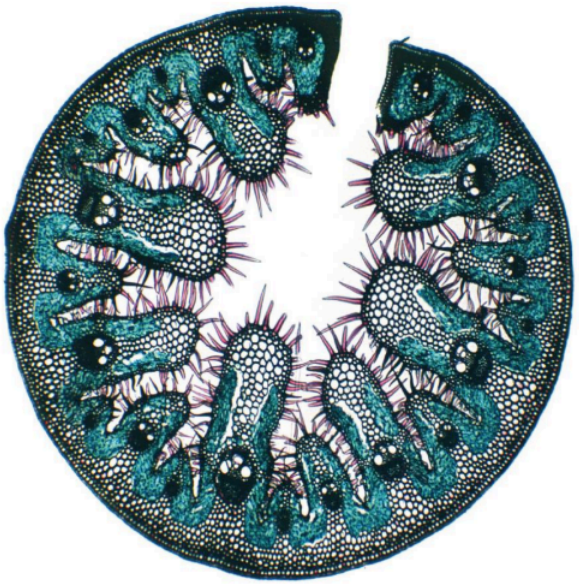
General pointers:
- If asked for IV and DV, write CV also even if not explicitly stated, could give extra marks
- Almost every experiment requires equilibrating / acclimitising something (temperature, pH buffer, lamp, colurimeter with DI water)
- Yeast suspensions /Bacterial Cultures / Enzymes may need pH buffers
- Absorbance has no units

ANNEX A (Prelim Papers / PYPs)



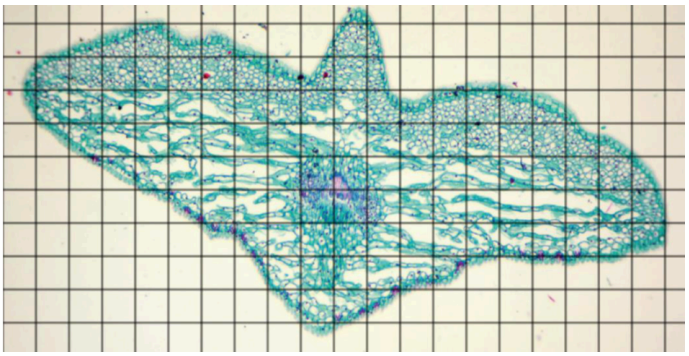


The Batman (Cross section of leaf)

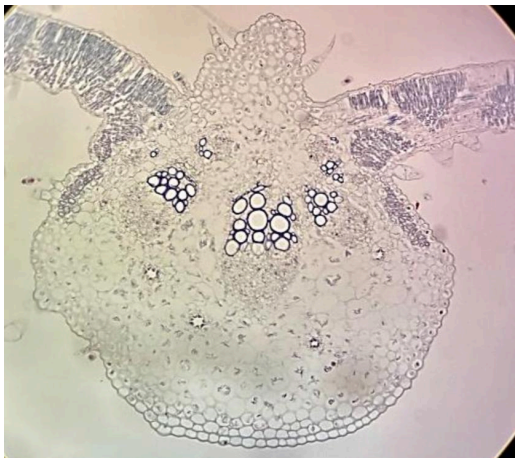


Goo goo muck (Transverse of a leaf)

1. Curved / curled leaf: increases humidity to reduce the water potential gradient, reducing water loss.;
2. Thick cuticle: reduces water loss by transpiration.;
3. Hair: traps water vapour inside the leaf.;



Another Batman (Cross section of leaf)



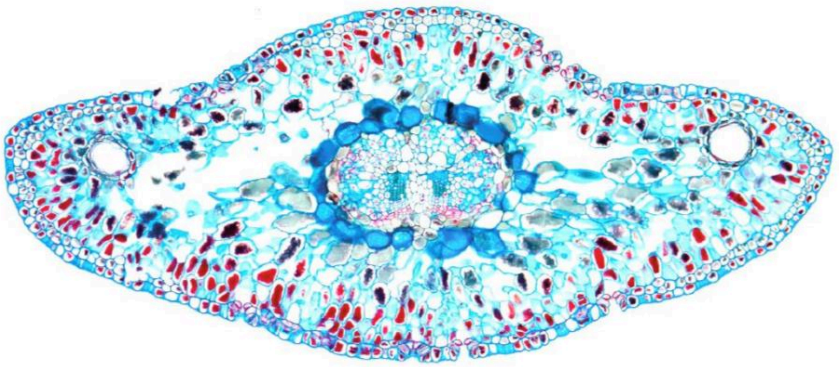


Fig. 3.1

Feature	J1	Fig 3.1
Vascular tissue	*Smaller proportion*	*Large proportion;*
Shape of vascular tissue	*Cone*	*Oval ;*
No. of vascular tissues	*Many / More than 1*	*One ;*
Air spaces	*Less*	*More;*
Shape of leaf	*Circular w. 2 (lamina) ext*	*Elongated / Elliptical ;*
Stomata	*Fewer*	*More;*
Palisade mesophyll	*Under upper epidermis*	*Absent ;*
Spongy mesophyll	*Under palisade mesophy*	*Uniformly around V.B ;*
Mid rib	*Prominent*	*Absent ;*
Thickness of lamina/blade	*Thin*	*Thick ;*

[3]