

Appendix 2 How to write laboratory reports

如何寫實驗報告

A2.1 Format of a formal laboratory report:

正規實驗報告的格式：

A formal report should include the following items :

正規的實驗報告應包括以下項目：

1. Aim
實驗目的
2. Hypothesis (if any)
假說(若有)
Don't put down a hypothesis unless it is necessary. (See A2.5)
除非真是有需要，否則莫寫假說。(參看下文 A2.5)
3. Design of the investigation: independent variable and dependent variable
實驗的設計：自變項和倚變項
4. Assumption (if any)
假設(若有)
5. Apparatus and material
儀器及物料
6. Procedure
程序
 - ✧ logically ordered and clearly written steps in **reported speech**
用**報告式語言**撰寫清晰及具邏輯性編排的實驗步驟
 - ✧ quantities : concentration/ temperature/ time/ amount/ volume/ etc. precisely stated
數量：精確地寫出濃度、溫度、時間、數量、體積等
 - ✧ **acclimatization** period clearly stated (if any)
清楚地寫出適應期(若有)
7. Control (if any)
對照(若有)
8. Diagrams of set-up
儀器裝置的繪圖
9. Sources of error/ precaution
誤差的來源及如何避免
10. Result (tabulate the result)
實驗結果(表列出來)
 - ✧ Table should include : title, heading, proper units
表格應包括：標題、項目及單位
 - ✧ Graph should have : title, labelled axis, points, curve, histogram, etc.
曲線圖應有：標題、有標示的縱橫軸、打點、曲線、棒形圖(若有)等



◇ Calculation/ slope calculation (if necessary)

計算：計算斜率或其他數據(若有)

11. Interpretation of results (looking for trends or relationships in the experimental data)

分析實驗結果（找出實驗數據所顯示的趨勢或關係）

12. Discussion

討論

13. conclusion

結論

A2.2 Techniques in tabulating the experiment results:

表列實驗數據的技巧：

A table should: (please pay attention to the colour of the words)

表格需：（請留意表格內字體的顏色）

(1) have a meaningful title;

有大標題；

(2) have proper heading for table columns;

每欄有適當的標題；

(3) have proper units in column headings;

標題欄附有適當的單位；

(4) include raw data;

包括原始數據；

(5) have calculation involved.

附有關的計算。



Example (1)

The result of experiment on the effect of temperature on enzyme activity

研究溫度對酶活性的影響的實驗結果

Temperature (°C) 溫度 (°C)	30	40	50	60	70	80	90
Time required for complete digestion of starch (S) 完全消化澱粉所需的時間 (S)	120	80	50	30	20	70	∞
1/time (x10 ⁻³ S ⁻¹) 1/時間 (x10 ⁻³ S ⁻¹)	8.3	12.5	20	33	50	14.3	0

Example (2)**The result of food tests on different food substances in common foodstuffs**

以食物測試找出常見食物的各種食物本質的實驗結果

Foodstuffs 食物本質	glucose 葡萄糖	reducing sugar 還原糖	starch 澱粉	lipid 脂肪	protein 蛋白質
bread 麵包					
grape 提子					
fresh milk 鮮奶					
spam 午餐肉					

Key : +++ large amount 大量

索引: ++ moderate amount 中量

+ minute amount 小量

- absent 沒有

Example (3)**The result of experiment on finding the water potential of potato by measuring the weight**

以量度重量的方法找出馬鈴薯的水潛能的實驗結果

Beaker 燒杯	Concentration of sucrose solution (M) 蔗糖溶液的 濃度 (M)	Initial weight (g) 起始重量 (g)	Final weight (g) 最終重量 (g)	Percentage of weight change (%) (final weight – initial weight)/initial weight 重量轉變的百分比 (%) (最終重量 – 起始重量)/起始重量
1				
2				
3				
4				
5				
6				
7				
8				

Example (4)

The result of experiment on the rate of anaerobic respiration of yeast by using different substrates.

研究酵母菌在不同食物的缺氧呼吸率的實驗結果

Substrate 基質	Cumulated volume of gas evolved 累積的釋出氣體體積 (ml)								
	Initial reading 起始讀數	10 min 分		20 min 分		30 min 分		40 min 分	
		Final reading 最終讀數	Cumulated gas evolved 累積氣體釋出	Final reading 最終讀數	Cumulated gas evolved 累積氣體釋出	Final reading 最終讀數	Cumulated gas evolved 累積氣體釋出	Final reading 最終讀數	Cumulated gas evolved 累積氣體釋出
Glucose 葡萄糖									
Sucrose 蔗糖									
Starch 澱粉									

Example (5)

The result of experiment on the effect of light intensity on the photosynthetic rate

研究光強度對光合作用速率的影響的實驗結果

Distance of hydrilla from table lamp 'd' (cm) 黑藻與檯燈的距離 'd' (cm)	d ²	Relative light intensity 'I' 相對光強度 'I'	Volume of bubbles in 5 minutes (ml) 5 分鐘內釋出的氣泡 (ml)
15		$15^2/15^2 = 1$	
20			
25			
30			
35			
40			

Example (6)

The result of experiment on the rate of transpiration at different environment.

不同環境對植物的蒸騰作用速率的影響的實驗結果

Environment 環境	Cumulated water uptake 累積吸收的水分 (ml)						
	Initial reading 起始讀數	10 min 分		20 min 分		30 min 分	
		Final reading 最終讀數	Cumulated water uptake 累積吸收的水	Final reading 最終讀數	Cumulated water uptake 累積吸收的水	Final reading 最終讀數	Cumulated water uptake 累積吸收的水
Dim light 暗光							
Bright light 強光							

Example (7)**To prepare a series of solution of different concentration (dilution table)****配製一系列不同濃度的溶液（稀釋表）**

Test tube 試管	1.0 M sucrose solution (ml) 1.0 M 蔗糖溶液 (ml)	Distilled water (ml) 蒸餾水 (ml)	Concentration of sucrose solution (M) 蔗糖溶液的濃度 (M)
1	5.0	5.0	0.50
2	4.5	5.5	0.45
3	4.0	6.0	0.40
4	3.5	6.5	0.35
5	3.0	7.0	0.30
6	2.5	7.5	0.25
7	2.0	8.0	0.20
8	1.5	8.5	0.15

A2.3 Techniques in plotting graph:**繪畫曲線圖的技巧：**

A good graph must be self-sufficient. We should be able to read data from the graph without going back to the original data. The message and information must be accurately represented by the graph. Therefore, a good graph should include:

一個良好的曲線圖必需能自我補足。我們不需要返回原始數據便能夠從曲線圖獲取有用的資料，良好的圖像必須能將資料和訊息準確地表達出來，因此一個良好的曲線圖須包括：

- (1) A clear and informative title to explain the purpose of the graph.

給曲線圖適當的標題以解釋該圖的目的。

- (2) Clear label and good choice of axis to explain what dependent and independent variables are involved

正確地選取 x 軸及 y 軸，並在兩軸上寫上項目名稱及單位，x 軸代表自變數，y 軸代表倚變數。

Usually, x axis represents the given experimental conditions such as temperature and concentration, and y axis represents experimental results such as ventilation rate and reaction rate, etc.

通常 x 軸代表實驗的條件如溫度、濃度等，y 軸則代表實驗結果如排氣速度、作用的速度等。

- (3) Proportional scale for clarity and prevention of misinterpretation.

定出 x 軸及 y 軸的適當比例以免誤導。

- (4) Complete keys and labels to the curves so that the meaning of each curve can be recognized.

在曲線上加上索引或標註以使曲線易於辨認。

- (5) Accurate plotting.

正確地繪上坐標並用線連好。

- (6) Correct choice of curve styles: in general, if we want to make prediction (to estimate a biological value) from the graph (between two data points or extrapolation), eg. to find the water potential of plant cells or the optimum temperature of enzymatic activity, a smooth curve is more appropriate. Under the special case like $y = mx + b$, or the graph is only used to show the trend of some phenomenon, a best straight line will be used.

正確地選擇曲線的形式，通常如果我們想從曲線圖中進行預測（估計一些生物數值），例如：在找尋植物細胞的水潛能或酶的最適溫度時，一個平滑的曲線圖會較為適當，否則，在特殊的情況下，如函數 $y = mx + b$ ，或圖像只想顯示某個生物現象的趨勢，則繪畫一直綫圖較佳。

A2.4 Formulation and testing of hypothesis in scientific investigations:

在科學探研中構思假說及對假說進行測試：

When we design an experiment in scientific investigations, sometimes we need a hypothesis, whereas sometimes not. At what circumstances should we need a hypothesis?

當我們在科學探究中設計實驗時，有時需要一個假說，有時卻不需要，究竟何時才需要一個假說呢？

Experiments that need a hypothesis:

需要假說的實驗：

A question that asks ‘why’ usually requires a hypothesis. In such case, we pose a question, and we propose a tentative explanation that tries to explain the scientific facts. That explanation is called hypothesis. If the hypothesis is correct, we should observe some expected results when a certain test is conducted. This guides us to plan observations or design experiments.

一個以「**為什麼**」作開首的問題通常需要一個假說，在這種情況，我們會設一問題，然後會建議一個未經驗證的解釋嘗試解答這一問題，便名為假說，若假說正確，在進行測試時便會得到預期的結果，這假說會帶引我們如何觀察及設計實驗。



這解釋

Example of questions that lead to hypothesis:

引致假說的問題的例子：

- Question: Why is salivary amylase still be very active at 70°C?
 問題：為什麼唾液澱粉酶在 70°C 仍然很活躍？
 Hypothesis: Salivary amylase may not be denatured at 70°C.
 假說：唾液澱粉酶可能仍未變質。
- Question: Why does the rate of photosynthesis become constant with increase in light intensity when the light intensity is high?
 問題：為什麼在高光強度時增加光強度不會令光合作用速率增加。
 Hypothesis: In high light intensity, other factors, say carbon dioxide, becomes limiting.
 假說：在高光強度時，其他因素，例如二氧化碳的供應可能變成限制因素。

3. Question: Why does a potato become softer after storing for a long time?
 問題： 爲什麼馬鈴薯在儲藏一段時期後變得柔軟？
 Hypothesis: The longer the time of storage, the more water is lost through transpiration. Or, The cell membrane is damaged during storage, so the cells lose their turgidity.
 假說： 儲藏時間越長，會有越多水透過蒸騰作用散失，或儲藏過久會破壞細胞膜，令細胞失去硬脹。
4. Question: Why is a potted plant placed outside the laboratory for two days without any water supply became wilt while a similar plant placed inside the laboratory not?
 問題： 爲什麼一盆盆栽植物置於實驗室外兩天不加淋水會凋謝，而相似的植物置於實驗室內卻不會呢？
 Hypothesis: The plant outside the laboratory became wilted because it has a higher transpiration rate due to the windy conditions outside. Or, The plant outside the laboratory became wilted because it is hotter outside.
 假說： 置於實驗室外的植物會凋謝因爲室外較大風令植物有較高的蒸騰作用率，或置於實驗室外的植物會凋謝因爲外面較熱。

Experiments that do not need a hypothesis:

不需要假說的實驗：

A question that asks ‘**what**’ usually requires making objective observations, it does not need a hypothesis.

一個以「**什麼**」作開首的問題通常只需客觀的觀察，它不需要一個假說。

Example of questions that do not lead to hypothesis:

不會引致假說的問題的例子：

- What will be the relationship between water temperature and the heating time?
This is not a hypothesis: Water temperature increases with heating time.
 水的溫度與加熱的時間有什麼的關係？
這不是一個假說： 水的溫度隨加熱的時間增加而增加。
- What is the optimum temperature for salivary amylase?
This is not a hypothesis: The optimum temperature for salivary amylase is 70°C.
 唾液澱粉酶的最適溫度是多少？
這不是一個假說： 唾液澱粉酶的最適溫度是 70°C
- What is the effect of light intensity on the rate of photosynthesis?
This is not a hypothesis: The rate of photosynthesis will increase with light intensity.
 光強度對光合作用速率有什麼影響？
這不是一個假說： 光合作用速率隨光強度增加而增加。



4. What is the water potential of potato cells?

This is not a hypothesis: The water potential of potato cells equal to the surrounding solution when no change of weight occurs.

馬鈴薯細胞的水潛能是多少？

這不是一個假說：當馬鈴薯塊置於一溶液內而不再改變重量時，馬鈴薯細胞的水潛能便等於該浸液的水潛能。

5. What food constituents are present in peanut, banana, grape, potato and biscuit?

This is not a hypothesis: I think that peanut, banana, grape, potato and biscuit all have proteins and lipids.

花生、香蕉、提子、馬鈴薯和餅乾有什麼的食物成分？

這不是一個假說：我認為花生、香蕉、提子、馬鈴薯和餅乾全都含有蛋白質和脂肪。

6. What is the respiration rate of mealworms?

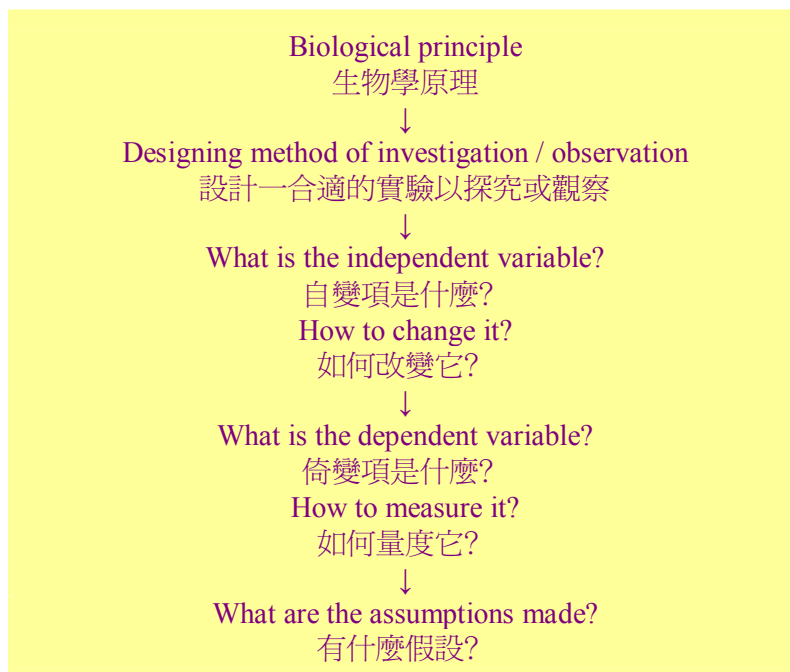
This is not a hypothesis: I think the respiration rate is constant.

麥皮蟲的呼吸率是多少？

這不是一個假說：我認為呼吸率是穩定的。

Flowchart of designing an experiment for investigation or observation:

為探究或觀察而需要設計實驗時的流程圖：



A2.5 Making assumption in scientific investigations:

在科學探研中設立假設：

Sometimes in order to draw a valid conclusion from the results, we have to make some assumptions.

有時爲了能從實驗結果中獲得有效的結論，我們需作一些假設。

Examples of some assumptions:

一些假設的例子：



- Experiment: To measure transpiration rate of plants by using a simple potometer.
 實驗：以簡單的蒸騰計量度植物的蒸騰作用速率。
 Assumption: Rate of water uptake = rate of transpiration.
 假設：所吸收的水 = 蒸騰作用速率
- Experiment: To find the water potential of potato cells by measuring the weight.
 實驗：以量度馬鈴薯細胞的重量來找出它的水潛能。
 Assumption: Change in weight of potato cylinder = amount of water uptake / loss by osmosis.
 假設：馬鈴薯薯條重量的改變 = 於滲透作用所吸收 / 散失的水的重量。
- Experiment: To find the growth rate of a plant by measuring the change in dry mass.
 實驗：以量度植物的乾重來找出它的生長速率。
 Assumption: Change in dry mass is proportional to amount of cytoplasm formed.
 假設：乾重的改變和所形成的原生質成正比。
- Experiment: To compare the sugar content of green, red and dark grapes by using Benedict's test.
 實驗：以本立德測試來比較青提、紅提及黑提的含糖量。
 Assumption: Amount of reducing sugar is proportional to total amount of sugar.
 假設：還原糖的數量與提子的總含糖量成正比。
- Experiment: Effect of light intensity on photosynthesis.
 實驗：光強度對光合作用的影響。
 Assumption: Rate of respiration remains constant in different light intensity; gas bubbles are identical in size.
 假設：在不同的光強度下，植物的呼吸率仍然維持穩定；氣泡的體積是一樣的。
- Experiment: To compare the vitamin C content of different food samples by using DCPIP solution
 實驗：以 DCPIP 溶液來比較不同食物樣本的維生素 C 含量。
 Assumption: Each drop of solution has the same volume; the end points are the same.
 假設：每滴溶液都是同等體積；終結點是相同的。
- Experiment: To compare the rate of anaerobic respiration of yeast by using different substrates.
 實驗：比較酵母菌在不同基質的缺氧呼吸率。
 Assumption: Air temperature and pressure unchanged; the yeast samples are identical.
 假設：氣溫與氣壓保持恆定，酵母菌的樣本完全一樣。

A2.6 The setup of controls:

對照的建立:

In order to draw valid conclusions from experimental results, the results of an experimental set-up have to be compared with that of a control set-up, which should be identical to the experimental set-up in all respects except for one variable or condition under study. By comparing the results of the experimental set-up and the control set-up, we can find out the effect of the factor under investigation. 為了能從實驗結果中下站得住腳的結論，實驗所得的結果必須和對照的作一比較，對照的設計除了和正在研究的變數或狀況不同外，其餘的設計必須和實驗完全相同。只要比較實驗裝置與對照實驗的結果，便能找出該物質或條件的影響。

Example (1) :

The following experiment is designed to find out whether light is necessary for photosynthesis.

以下實驗設計是用來找出光合作用是否需要光。

If starch is present in region A but absent in region B after exposing the plant to sunlight for several hours, which region is the control? Why?

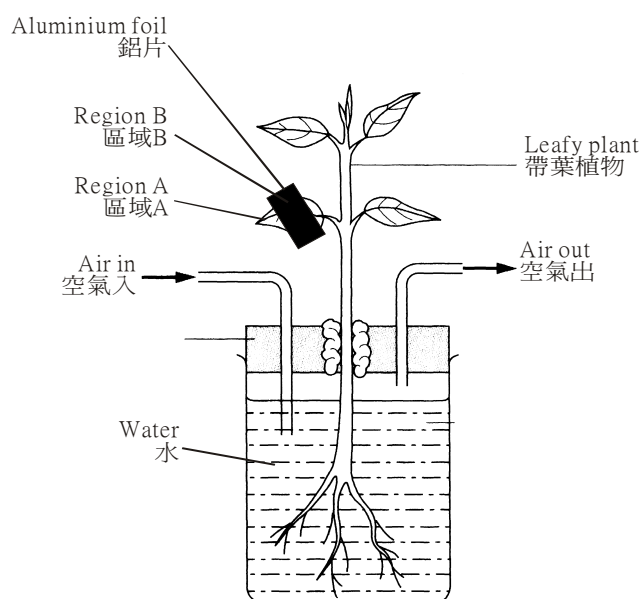
如果植物在暴露於陽光下數小時後作澱粉測試，澱粉存在於區域 A 但不存在於區域 B，那區是對照？請解釋。

Answer : region B is the control.

答案：區域 B 是對照。

Explanation: The control set-up should be the same as the experimental set-up except that the leaves should be covered up by aluminium foil (to exclude light).

解釋：對照的裝設須和實驗的裝設相同，除了樹葉應被鋁片遮蓋外(使它沒光)。



General rule 常規:

The set-up receiving a certain treatment is the experimental set-up (region A with light) while the one without the treatment (region B without light) is the control set-up.

那一裝設需要接受某些處理的便為實驗設計(區域 A 有光)而不需接受處理的(區域 B 沒光)便為對照設計。

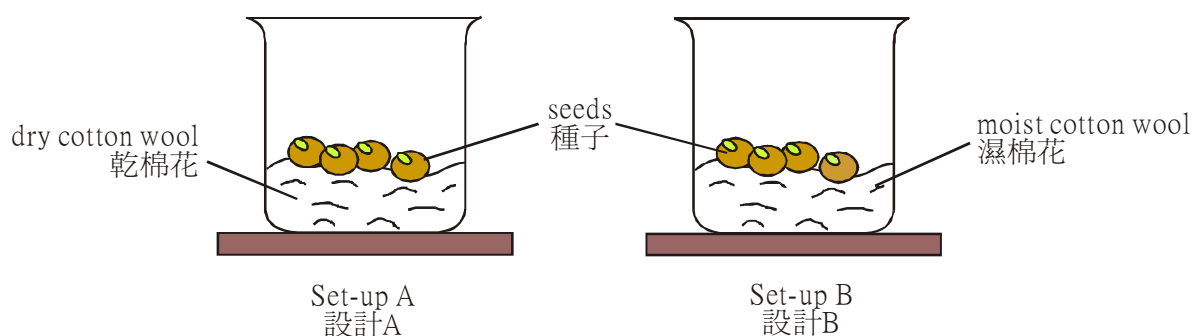
Example (2) :

The following experiment is designed to study the conditions for seed germination.

以下的實驗設計是用來研究種子萌發所需的條件。

If germination takes place in set-up B but not in set-up A, which set-up is the control? Why?

若種子萌發只在設計 B 發生而不在設計 A 發生，那一個設計是對照？請解釋。



Answer : set-up A is the control.

答案：設計 A 是對照。

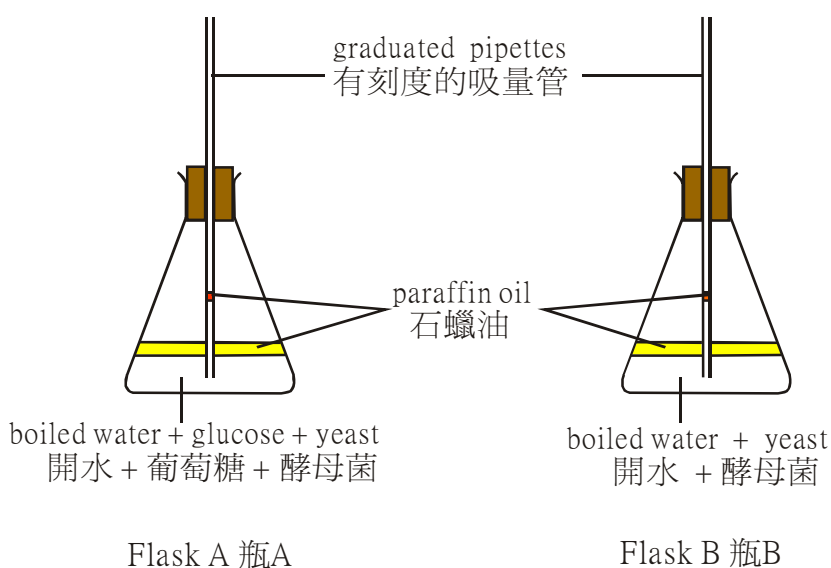
Explanation: The experimental set-up (set-up B) received a certain treatment (water), but the control set-up (set-up A) did not receive the treatment (only dry cotton wool), so it is the control.

解釋：實驗設計(設計 B)接受了特別處理(有水)，但對照設計(設計 A)沒有受同樣處理(只有乾棉花)，故此它是對照。

Example (3) :

In the following diagrams, which flask is the control? And what conclusions can be drawn about the conditions for anaerobic respiration after observing the results.

在下圖中，那一個瓶是對照？在觀察完實驗結果後，我們可在缺氧呼吸的情況中下什麼結論？



Answer : Flask B is the control.

答案：瓶 B 是對照。

The conclusion is glucose is needed in anaerobic respiration.

結論是缺氧呼吸需要葡萄糖。

Note : No valid conclusion can be made from the results of two set-up if they differ in more than one factor.

注意：如果在兩個裝設中有多於一個不同的因素(變數)，便不能從實驗結果中下結論。