

Country: _____

Student Code: _____

23rd INTERNATIONAL BIOLOGY OLYMPIAD

8th – 15th July, 2012

SINGAPORE



PRACTICAL TEST 3

PLANT DIVERSITY, ANATOMY & PHYSIOLOGY

植物多樣性、解剖及生理學

Total points: **100**

Duration: **90 minutes**

Dear Participants

- In this test, you have been given the following two tasks:
- 本實作分成兩部分

Task I: Plant diversity and anatomy. (60 points)

第一部分: 植物多樣性及解剖學 (60 分)

Part A: Morphology of seedlings (14.25 points) 小苗形態

Part B: Seed morphology and anatomy (27 points) 種子形態及解剖學

Part C: *Ficus* propagule dissection (5 points) 榕屬植物繁殖體的切片解剖

Part D: Functional, ecological and phylogenetic aspects of seeds and seedlings (18 points) 種子及小苗的功能、生態及親緣關係

Task II: Plant anatomy and physiology. (40 points)

第二部分: 植物解剖及生理學 (40 分)

Part A: Anatomy of a plant stem (13 points) 某植物莖的解剖學

Part B: Study of leaf epidermis and physiology (17 points) 探討葉片表皮及其生理學

Part C: Interpretation of photosynthetic data (10 points) 光合作用數據的解讀

- Use the **Answer Sheet**, which is provided separately, to answer all the questions.

請將答案寫在答案紙上

- The answers written in the Question Paper will **NOT** be evaluated.

寫在試卷上的答案將不予計分

- Write your answers legibly in ink (you may use a pencil for diagrams).

以原子筆清楚作答 (你可以用鉛筆畫圖)

- Please make sure that you have received all the materials and equipment listed for each task.

If any of these items are missing, please raise your hand **immediately**.

請確切檢查每個部分所提供的材料及器材, 若有任何缺失, 請立即舉手

- Stop answering and put down your pen IMMEDIATELY when the bell rings.

鈴響時, 應立即停止作答並放下原子筆

- At the end of the test, place the Answer Sheets and Question paper in the envelope provided.

Our Assistants will collect the envelope from you.

實作結束時, 把答案紙及試卷放進所提供的信封中, 監試人員會來收卷

Have fun and Good Luck! 😊

Materials and equipment: 材料及器材

For Task I: Plant diversity and anatomy 第一部分: 植物多樣性及解剖學

Materials and equipment	Quantity	Unit
Seedlings: A, B, C and D (in plastic cups) 四種小苗 A, B, C and D (置於塑膠杯中)	1	specimen 標本
Seeds/propagules: 1 to 7 (in labelled plastic bags) 種子/繁殖體 1 ~ 7 (置於有編號的塑膠袋中)	1	specimen 標本
Specimen E (in labelled plastic bag) 標本 E (置於有編號的塑膠袋中)	1	specimen 標本
razor blade (use only for seed 3 and seed 5)刀片(用於種子 3 及 5)	1	Piece 片
scissors (use for seed 4 and specimen E) 剪刀(用於種子 4 及標本 E)	1	Pair 把
hand lens 小型放大鏡	1	Piece 支

For Task II: Plant anatomy and physiology 第二部分: 植物解剖及生理學

Materials and equipment	Quantity	Unit
Leaves, L (in petri dish L) 葉片 L (置於 L 培養皿中)	2	Piece 個
Stems, S (in petri dish S) 莖段 S (置於 S 培養皿中)	2	Piece 個
concentrated HCl (in bottle labelled H, placed within a beaker) 濃鹽酸 (放在燒杯內且標示 H 的瓶中)	1	Bottle 瓶
Phloroglucin stain (in bottle labelled P) Phloroglucin 染劑 (標示為 P 的瓶中)	1	Bottle 瓶
water (in wash bottle) 水 (洗瓶中)	1	Bottle 瓶
filter paper 濾紙	2	Sheet 張
Forceps 鑷子	1	Pair 支
razor blade 刀片	2	Piece 片
plastic dropper 塑膠滴管	1	Piece 個
petri dish (with water, labelled W) 裝了水的培養皿 (標示為 W)	1	Piece 個

petri dish (labelled LL, LU and SS with the correct student code) 培養皿 (標示為 LL, LU 及 SS 並有正確的考生編號)	3	Piece 個
beaker (small) 小燒杯	1	Piece 個
glass slides 載玻片	3	Piece 片
cover slips 蓋玻片	3	Piece 片
compound microscope 光學顯微鏡	1	Set 台

Task I (60 points)

Plant diversity and anatomy 第一部分: 植物多樣性及解剖學

Part A. Morphology of seedlings (14.25 points) 小苗形態 (總共 14.25 分)

Q1.1 (0.5 points × 20 = 10 points; 2 points for quality of drawing; 2.25 points for not damaging specimens) 每小點 0.5 分, 共 10 分; 繪圖清楚程度, 2 分; 保持標本完整、未遭破壞, 2.25 分

Make a simple schematic diagram of each seedling (A – D) in the corresponding space provided **in the Answer Sheet** and label the following (if present) with a to e and indicate if any are absent: 在答案紙上的對應方格中, 分別畫出小苗 A – D 的簡圖, 用下列所示的英文字母 (a~e) 來標示出適當構造, 並將該小苗沒有的構造, 填在該方格下方橫線上。

- Cotyledons 子葉
- Epicotyls 上胚軸
- Hypocotyls 下胚軸
- Leaves 葉片
- seed coat 種皮

Part B. Seed morphology and anatomy (27.25 points) 種子形態及解剖學

Each seedling (A to D) from Part A comes from seeds 1-4 respectively.

前題所用的小苗分別來自種子 1-4

Q1.2 (0.25 points × 11 = 2.75 points) 每小點 0.25 分, 共 2.75 分

Draw each whole seed (1 – 6) in the corresponding space provided **in the Answer Sheet**

(Note: (1) you do not need to draw Seed 7; (2) seed coat of Seed 5 has been removed).

Label the following (if present) with a and b and indicate if any part is absent:

在**答案紙上**的對應方格中, 分別畫出整個種子 1 – 6 的簡圖, (注意: 不用畫種子 7; 種子 5 的種皮已經被移除), 用下列所示的英文字母(a 及 b)來標示出適當構造, 並將該種子沒有的構造, 填在該方格下方橫線上。

a. seed coat 種皮

b. site of attachment of funiculus 連接在胚珠柄的位置

Q1.3 (0.5 points × 24 = 12 points; 1 point for quality of drawing) 每小點 0.5 分, 共 12 分; 繪圖
清楚程度, 1 分

After drawing the exterior of each seed, dissect in longitudinal section and draw the sectioned seed in the corresponding space provided **in the Answer Sheet**. (Note: Some seeds have been pre-cut for your convenience. The seed coat of Seed 5 has been removed.).

Label/indicate the following items on your diagram with a to d:

在畫完每個種子的外形後, 將種子縱切, 在答案紙上的對應方格中, 分別畫出種子的縱剖面圖, (注意: 部分種子已先幫你切好了; 種子 5 的種皮已經被移除), 並用下列所示的英文字母(a ~ d)來標示出適當構造

- a. cotyledons 子葉
- b. food storage 養分儲存處
- c. hypocotyls 下胚軸
- d. seed coat 種皮

Q1.4 (0.5 points × 23 = 11.5 points) 每小點 0.5 分, 共 11.5 分

Indicate the likely ploidy (1N, 2N or 3N) of each of the items labelled “a” to “d” in Q1.3 **in the Answer Sheet**.

在答案紙上的表格中填入Q1.3所用的種子各構造(a ~ d)之染色體套數(1N, 2N or 3N)

Part C. *Ficus* propagule (dispersal unit) (5 points) 榕屬植物繁殖體(散播單位) (5 分)

Q1.5 (1 + 1 + 3 points) Dissect Specimen E longitudinally and draw the longitudinal section of the propagule (dispersal unit). Draw and label an enlarged section to show in detail the features of a to c.

將標本 E 作縱切, 先畫出此繁殖體(散播單位)的縱切面, 再畫出一小部分放大圖指出下列微細部分(a ~ c)

-
- a. fruit 果實
 - b. seed 種子
 - c. stigma 柱頭

Part D. Functional, ecological and phylogenetic aspects of seeds and seedlings (13.5 points)

種子及小苗的功能、生態及親緣關係(13.5 分)

Q1.6 (0.5 points × 9 = 4.5 points) 每小點 0.5 分, 共 4.5 分

Based on the observations in Parts A, B and C, and the information given in the Table provided **in the Answer Sheet**, indicate the primary function of the cotyledon with P (for photosynthesis) or S (for storage of nutrients) and the probable germination pattern with O (orthodox: seed can undergo dormancy) or R (recalcitrant: seed does not undergo dormancy). 根據在以上A, B and C三項中的觀察,與答案紙上所提供的表格, 寫出該子葉的主要功能: P代表光合作用或是S代表儲存養分, 以及種子可能萌發型式: O代表種子可進入休眠或是R代表種子不會進入休眠。

Q1.7 (1 point × 5 = 5 points) Based on the information in the Table and the diagrams that you have drawn, determine if each of the following statements is true (✓) or false (✗).

根據以上表格及你所畫的圖, 判斷下列敘述的真(✓)或偽(✗)。

- a. All tropical plants have recalcitrant seeds.
所有熱帶植物皆為種子不休眠型
- b. Gymnosperms have at most two cotyledons.
裸子植物大多具有 2 片子葉
- c. Cotyledon function is phylogenetically constrained within plant families.
子葉功能可顯示植物有親緣關係之重要特徵

- d. Seed size varies considerably in plant families and is probably not phylogenetically constrained. 同科植物的種子大小差異很大, 且可能不會是顯示科內親緣關係之重要特徵
- e. Large seed size may be advantageous for some tropical rainforest plants.
大型種子可能對某些生長在熱帶雨林之植物是有利的

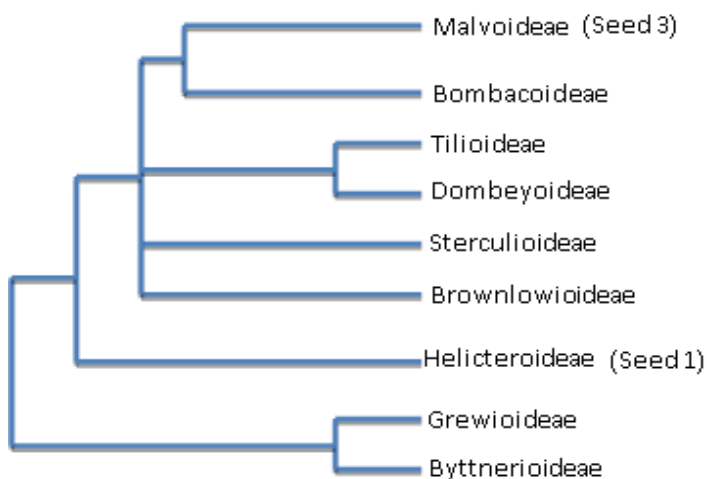
Q1.8 (1 point × 4 = 4 points) The phylogenies of Malvaceae and Moraceae, and a simplified phylogeny of seed plants are provided on the next page. Using this information, as well as the specimens that you have observed today, determine if each of the following statements is true (✓) or false (✗), or if there is insufficient evidence to conclude (–) **in the Answer Sheet.**

在下一頁的圖分別為錦葵科(Malvaceae)與桑科(Moraceae)親緣關係樹、及種子植物之簡化親緣關係樹。根據此資訊以及在本實作中你所觀察的標本, 判斷下列敘述的真(✓)或偽(✗), 或用(–)代表證據不足以判斷, 請在答案紙上以適當符號標示。

- a. Large seeds have evolved independently in multiple lineages.
大型種子分別在多個不同支系中出現
- b. Large seeds have evolved on more than one occasion in some lineages.
大型種子在某些支系中已經重複演化過多次
- c. Recalcitrant seeds are more associated with tropical plants than with temperate plants.
相對於溫帶植物, 不休眠型的種子與熱帶植物比較有相關
- d. Gymnosperms are unable to produce fleshy structures associated with animal dispersal because they lack ovaries.
裸子植物不能產生與動物傳播有關的多汁構造, 因為這些植物沒有子房

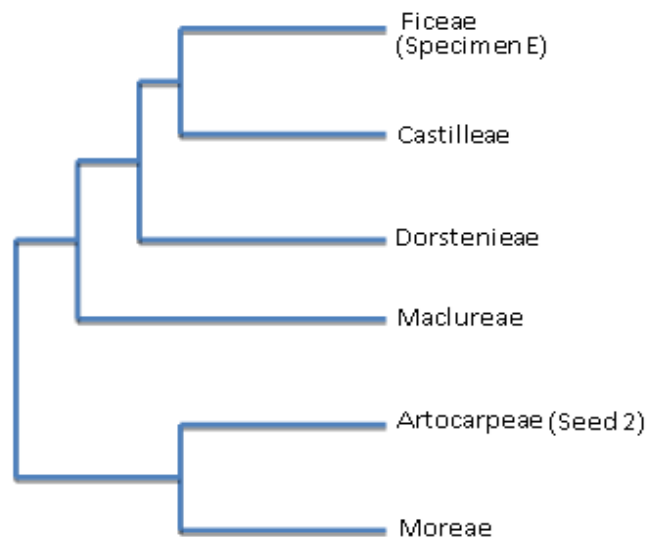
Phylogeny of Malvaceae

錦葵科親緣關係樹

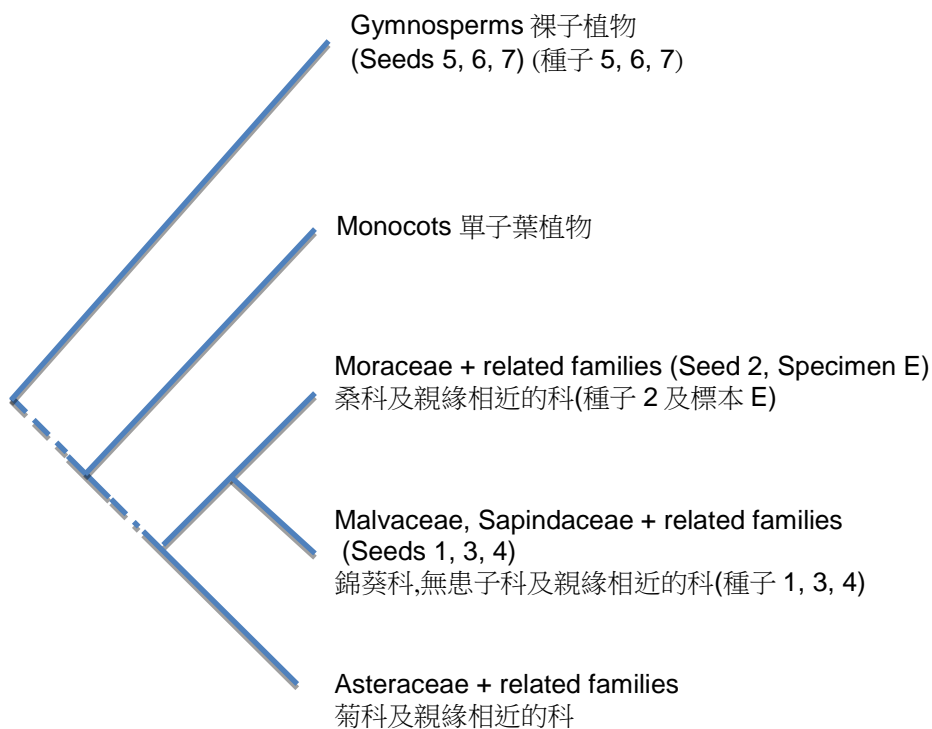


Phylogeny of Moraceae

桑科親緣關係樹



Simplified phylogeny of seed plants 種子植物之簡化親緣關係樹



Task II (40 points)

Plant anatomy and physiology 植物解剖及生理學

Part A. Anatomy of a plant stem (13 points) 某植物莖的解剖學

Procedure: 步驟

1. Using the razor blade, cut as thin as possible transverse sections of the stem, S.
用刀片將莖橫切(盡可能切薄)
2. Float the cross-sections in water in petri dish, W.
將切下的切片浮在裝水的培養皿 W 中
3. Place a drop of water onto a glass slide and transfer the best cross-section to the centre of the slide. 在載玻片加一滴水並取最好的切片放在玻片中央
4. Place a small drop of phloroglucin stain (P) onto the cross-section, followed by a small drop of concentrated hydrochloric acid, HCl (H). Be very careful when handling H as it is corrosive.
加一滴 phloroglucin 染劑(P)在橫切切片上, 再加一滴濃鹽酸(H) (注意:小心使用強酸)
5. Leave for 1 minute and then remove excess stain with the filter paper.
等一分鐘, 然後以濾紙將多餘染料吸掉
6. Cover the cross-section with a coverslip and examine it using the compound microscope under low magnification (4× objective lens).
蓋上蓋玻片, 在光學顯微鏡下以低倍(4×)物鏡觀察

Answer the following questions **in the Answer Sheet:** 在答案紙上回答下列問題

Q2.1 (1 point) Is S a monocot stem or dicot stem? Indicate M for monocot and D for dicot.

S 為單子葉或雙子葉植物的莖?用 M 代表單子葉; D 代表雙子葉

Q2.2 (1 point) Is there any pith? Indicate presence of pith with a tick (✓) and absence with a cross (✗).

此莖切片中有髓嗎? 以(✓)代表有; (✗)代表無

Q2.3 (1 point) Where is the vascular bundle in the stem located? Indicate centre with C and periphery with P.

維管束位於此莖中的何處? 以 C 代表中央; P 代表近邊緣

Q2.4 (0.5 points × 3 = 1.5 points) Based on your observations, is S the stem of a shrub, tree, or herb? Indicate correct answer(s) with a tick (✓) and incorrect answer(s) with a cross (✗) **in the Answer Sheet.**

根據你的觀察, S是灌木、喬木或草本植物的莖? 在答案紙上分別以(✓)代表正確、(✗)代表錯誤

Q2.5 (0.5 points) Identify the tissue (a – e) that is stained red. Indicate the correct answer with a tick (✓) **in the Answer Sheet.**

在答案紙上以(✓)標出下列哪個組織會染成紅色?

- a. cortex 皮層
- b. endodermis 內皮
- c. epidermis 表皮
- d. phloem 韌皮部
- e. xylem 木質部

7. When you have completed Part A, place your slide with the stem section into the petri dish SS for grading purposes. 當你完成 Part A, 將你作好的切片玻片放在標有 SS 的培養皿中, 以作為評分之用。

Q2.6 (8 points)

Part B. Study of leaf epidermis and physiology (17 points) 探討葉片表皮及其生理學

(i) Lower epidermis 下表皮

Procedure: 步驟

1. Peel off the lower epidermis of the leaf, L, with a pair of forceps.

以鑷子撕下葉片 L 的下表皮

2. Place it in a drop of water on a glass slide and cover the peeled layer with a cover slip.

載玻片上加一滴水, 將下表皮放在水中, 再蓋上蓋玻片

3. Examine it using the compound microscope under 10× objective lens.

在光學顯微鏡 10×物鏡下檢視之

Answer the following questions **in the Answer Sheet**: 在答案紙上回答下列問題

Q2.7 (2 points) Do you see any stomata? Indicate presence of stomata with a tick (✓) and absence with a cross (✗).

有看到氣孔嗎?以(✓)代表有; (✗)代表沒有

Q2.8 (3 points) Measure the lengths and widths of FIVE (5) epidermal cells that are representative of the majority of the cells. Smallest unit in the eyepiece micrometer as seen under 10× objective lens is 10 μm. Calculate the mean values and fill in your answer in the table provided.

測量 5 個可代表大部分細胞形態的表皮細胞之長度與寬度, 10×物鏡下的目鏡測微尺之最小刻度為 10 μm, 計算其平均的長度與寬度, 並填入表中。

4. When you have completed Part B (i), place your slide with the epidermal peel into the petri dish LL for checking purposes. The slide will also be used to check for accuracy of your measurement of epidermal cell dimensions.

當你完成 Part B (i), 將你作好的表皮玻片放在標有 LL 的培養皿中, 以作為檢查你的測量是否正確之用。

(ii) Upper epidermis 上表皮

Procedure: 步驟

1. Peel off the upper epidermis of the leaf, L, with a pair of forceps. You may either use the same leaf as before or a fresh leaf from petri dish L.

以鑷子撕下葉片 L 的上表皮, 你可用之前使用的葉片, 或再從培養皿 L 中取另一新鮮葉片

2. Place it in a drop of water on a glass slide and cover the peeled layer with a cover slip.

載玻片上加一滴水, 將下表皮放在水中, 再蓋上蓋玻片

3. Examine it using the compound microscope under 10× objective lens.

在光學顯微鏡 10×物鏡下檢視之

Answer the following questions **in the Answer Sheet**: 在答案紙上回答下列問題

Q2.9 (2 points) Do you see any stomata? Indicate presence of stomata with a tick (✓) and absence with a cross (✗).

有看到氣孔嗎?以(✓)代表有; (✗)代表沒有

Q2.10 (3 points) Measure the lengths and widths of FIVE (5) epidermal cells that are representative of the majority of the cells. Smallest unit in the eyepiece micrometer as seen under 10× objective lens is 10 μm. Calculate the mean values and fill in your answers in the table provided.

測量 5 個可代表大部分細胞形態的表皮細胞之長度與寬度, 10×物鏡下的目鏡測微尺之最小刻度為 10 μm, 計算其平均的長度與寬度, 並填入表中。

4. When you have completed Part B (ii), place your slide with the epidermal peel into the petri dish LU for checking purposes. The slide will also be used to check for accuracy of your measurement of epidermal cell dimensions.

當你完成 Part B (ii), 將你作好的表皮玻片放在標有 LU 的培養皿中, 以作為檢查你的測量是否正確之用。

Q2.11 (0.5 point × 3 = 1.5 points) Based on your observations in Part B (i) and (ii), indicate the correct answer(s) with a tick (✓) and incorrect answer(s) with a cross (✗).

根據你在 Part B (i) 及 (ii) 的觀察, 判斷下列敘述的正確(✓)或錯誤(✗)。

a. There are more stomata in the lower epidermis than in the upper epidermis.

下表皮的氣孔較上表皮多

b. Epidermal cells of the upper epidermis are smaller than those of the lower epidermis.

上表皮的表皮細胞較下表皮小

c. Stomata are separated from each other by at least one cell.

氣孔之間至少有一個表皮細胞將它們隔開

Q2.12 (1 point) Based on your observations, determine what type of plant this is. Indicate the correct answer with a tick (✓) **in the Answer Sheet.**

根據你的觀察, 判斷此植物為哪一類型? 在答案紙上的適當空格打鉤(✓)

a. hydrophyte 水生植物

b. mesophyte 中生植物

c. xerophyte 旱生植物

Q2.13 (0.5 point × 5 = 2.5 points) Some statements about stomatal structure, function and development are given below. Indicate true statement(s) with a tick (✓) and false statement(s) with a cross (✗).

下列有關氣孔構造、功能及發育之敘述, 判斷其真(✓)或偽(✗)

- a. Stomata consist of a pair of highly specialized guard cells that are usually surrounded by a pair of larger subsidiary cells.

氣孔由一對高度特化的保衛細胞所構成, 且通常被一對較大的副衛細胞所包圍

- b. Guard cells differ significantly from other epidermal cells in that they have chloroplasts.

保衛細胞與其他表皮細胞的顯著差別在於保衛細胞具有葉綠體

- c. Chloroplasts of guard cells differ from mesophyll chloroplasts in that they lack grana.

保衛細胞的葉綠體不同於葉肉組織的葉綠體: 保衛細胞的葉綠體沒有基粒(grana)

- d. The number of stomata on any leaf surface is under genetic control and is not modified by any environmental factors.

任何葉片表面的氣孔數目是由基因調控, 不會因任何環境因子而改變

- e. Stomatal development involves asymmetric cell divisions.

氣孔的發育與細胞的不對稱分裂有關

Part C. Interpretation of photosynthetic data from plants measured at different CO₂ concentrations

(12 points) 植物在不同CO₂濃度下所測得之光合作用數據的解讀

Introduction 簡介

Single leaves from plants A and B that had been grown under full sunlight in the same greenhouse were studied. The responses of their net photosynthetic CO₂ assimilation rates to varying levels of ambient CO₂ under saturating light intensity of 1,200 μmol quanta m⁻² s⁻¹ at 25 °C and 21% O₂ measured on leaves in the laboratory are given on the next page:

分別取生長在同一溫室有充分陽光照射的植物A 及 B的一片葉子來進行實驗, 在光照強度 1,200 μmol quanta m⁻² s⁻¹、及 25 °C、21% O₂條件下, 改變環境中的CO₂濃度後, 測得葉片上的淨光合作用CO₂同化作用速率並如下表所示:

Ambient CO ₂ concentration (μl l ⁻¹) 環境中的CO ₂ 濃度	Net photosynthetic CO ₂ assimilation rate 淨光合作用CO ₂ 同化作用速率(μmol CO ₂ m ⁻² s ⁻¹)	
	Plant A	Plant B
20	0.5	-4
40	11	-1
60	19	2.5
80	28	5.5
100	33	9
180	41	18
300	44	27
400	44	32
600	44	40
800	44	44
1000	44	45.5

Q2.14 (4 points). Plot a graph by using the data above for Plant A and B in Graph 1 provided **in the Answer Sheet**. Use an X-axis scale from 0 to 1000 μl l⁻¹.

以上表所提供之植物A及B的數據,在答案紙上畫出曲線圖(圖1),X軸代表CO₂濃度(標示刻度範圍: 0 ~ 1000 μl l⁻¹)

Based on Graph 1, answer the following questions **in the Answer Sheet**:

根據圖1在答案紙上回答下列問題

Q2.15 (1 point) Indicate whether plants A and B are C₃ or C₄ plants. Indicate the correct answers with a tick (✓) **in the Answer Sheet**.

分別指出plants A及B為C₃或C₄植物,在答案紙上正確空格中打鉤(✓)

Q2.16 (2 points) What is the net photosynthetic CO₂ assimilation rate for Plant A and Plant B measured at 200 μl l⁻¹ of CO₂ concentration?

在 200 μl l⁻¹ CO₂濃度下, 分別寫出Plant A 及 Plant B的淨光合作用CO₂同化作用速率為何?

Q2.17 (2 points) Plot another graph by using CO₂ assimilation rate from 20 to 100 μl l⁻¹ of CO₂ concentration only (i.e., at low CO₂ concentrations) for Plant B in Graph 2 provided **in the Answer Sheet**. Use an X-axis scale from 0 to 100 μl l⁻¹.

在答案紙上, 改僅採用Plant B 在 20 ~100 μl l⁻¹ CO₂濃度下所測得之CO₂同化作用速率來作圖(圖2), X軸代表CO₂濃度(標示刻度範圍: 0 ~ 100 μl l⁻¹)

Q2.18 (1 point) Based on Graph 2, what is the CO₂ compensation point for plant B? Write the value **in the Answer Sheet**.

根據圖 2, Plant B的CO₂補償點為何? 在答案紙上作答

Q2.19 (1 point) Compared to the data in Graph 2, would the CO₂ compensation point increase, decrease or remain unchanged if the measurements were carried out at 35 °C and 21% O₂? Indicate the correct answer(s) with a tick (✓) **in the Answer Sheet**.

比較圖 2 中的數據, 倘若改在 35 °C 、 21% O₂條件作相似的測量, 則CO₂補償點將會增加或減少或維持不變? 在答案紙上適當空格中作答(✓)

Q2.20 (1 point). Compared to the data in Graph 2, would the CO₂ compensation point increase, decrease or remain unchanged if the measurements were carried out at 25 °C and 2% O₂? Indicate the correct answer(s) with a tick (✓) **in the Answer Sheet**.

比較圖 2 中的數據, 倘若改在 25 °C 、 2% O₂條件作相似的測量, 則CO₂補償點將會增加或減少或維持不變? 在答案紙上適當空格中作答(✓)

END OF PAPER