27th International Biology Olympiad

July 17-23, 2016
Hanoi, Vietnam

Practical Exam 1

PLANT ANATOMY AND PHYSIOLOGY

Total points: 91
Duration: 90 minutes

DEAR PARTICIPANTS,

This exam consists of three experiments:
本實作包括三個實驗

EXPERIMENT 1. LEAF PIGMENT ASSAY (30 points)
實驗**1.** 葉片色素分析**(30**分**)**

Task 1. Pigment quantitative determination by spectrophotometer
第1部分 利用分光光度計進行色素定量

Task 2. Pigment qualitative determination by TLC
第2部分 利用薄層色層分析 (TLC) 進行色素定性

EXPERIMENT 2. PLANT ANATOMY (31 points)
實驗**2.** 植物解剖 **(31**分**)**

Task 3. Observe the anatomical characters of four samples
第3部分 觀察四種材料的解剖特徵

Task 4. Make the data matrix and identify the position of each sample in a given phylogenetic tree
第4部分 做出一數據矩陣，並在所提供的親緣關係樹上確定每個材料的位置

Task 5. Draw the detailed structures of that vascular bundle
第5部分 畫出維管束的詳細構造

EXPERIMENT 3. IDENTIFICATION OF PLANT SPECIES AND MAKE THE DATA MATRIX (30 points)
實驗**3.** 鑑定植物種類及建置數據矩陣 **(30**分**)**

Task 6. Identify morphological and anatomical characters of five given floral samples
第6部分 由所提供的5種花的材料鑑定個別的形態及解剖特徵

Task 7. Name samples PG-PK using a given dichotomous key
第7部分 利用所提供的檢索表，鑑定出材料 PG-PK 的名稱

Task 8.Make the data matrix
第8部分 建置數據矩陣

A. Please remember to write your **Country** and **Student code** in the given box.
記得在指定空格中填寫 國名 及 學生編號

B. Write your answers in the separate **Answer Sheet**. Only the answers given in the **Answer Sheet will be evaluated**.
將答案填在答案紙上，只有在答案紙上的答案才會評分

C. Make sure that you have received all the materials and equipment listed. If any of these items are missing, please raise the **Red card** within 10 minutes immediately.
先確定桌上有所有列出的器材，若有任何缺少者，請在10 分鐘內立刻舉起紅牌

D. During experiments, ensure to handle equipment properly. Any spilled solutions or broken equipment will not be replenished.
整個實驗過程中，請小心使用器材，若有任何溶液漏失或器材破損，都不再補充

E. Stop answering and put down your pen immediately when the bell rings at the end of the exam. Enclose the **Answer Sheet**, **Question Paper**, and **Data printout** in the provided envelope.
當實作結束的鈴聲響起時，應立即放下筆、停止作答。將答案紙、試題卷及列印出的數據單一併放入所提供的信封中

F. No paper, materials or equipment should be taken out of the laboratory
不能將紙張、材料或儀器帶出實驗室

G. Ensure to obtain spectrophotometer readings in Task 1 and to answer the questions that follow.
在第1部分，務必要拿到分光光度計所測出的數據，以便回答該題目之下相關的問題

CAUTIONS: This experiment deals with materials that are fragile and sharp. Exercise care when handling these materials. Do not let them get in contact with your skin or clothes. Wear safety goggles to protect your eyes from splashes.
注意: 本實驗會用到易碎及鋒利的器材，應小心操作! 避免皮膚或衣服沾上藥品，戴護目鏡以保護眼睛，避免被藥品噴到

Good luck!!!

EQUIPMENT AND MATERIALS FOR 3 EXPERIMENTS

三個實驗的器材

Experiment 1. Leaf pigment assay 實驗***1.*** 葉片色素分析

Name 名稱	**Quantity** 數量
Soybean leaf samples (sample A and sample B) 大豆葉片 (標本 A 及標本 B)	2 microcentrifuge tubes 2 個微量離心管
Positive control 正對照組	1 microcentrifuge tube 1 個微量離心管
TLC plate with student code in a plastic bag 薄層色層分析板 (有標示學生編號)，置於塑膠袋中	1 piece 1 片
Cuvettes 光電比色管	2 pieces 2 個
95% ethanol 95% 酒精	40 mL in falcon tube 40 mL (於大離心管中)
Ethanol for washing pipette 洗微量吸管用的酒精	20 mL in falcon tube 20 mL (於大離心管中)
Chromatography solvent (n-hexane : acetone = 7:3 in volume) 色層分析溶劑 (n-hexane : acetone 其容積比 7:3)	25 mL in TLC bottle 25 mL 於TLC 瓶中
Mortars and pestles 研缽及杵	2 pieces 2 組
Falcon rack 大離心管架	2 pieces 2 個
Funnels 漏斗	2 pieces 2 個
Filter papers 濾紙	2 pieces 2 張
Forceps 鑷子	1 pairs 1 支
1 mL glass pipette 1 mL 玻璃滴管	2 pieces 2 支
5 mL glass pipette 5 mL 玻璃滴管	1 piece 1 支
Pipetting ball 吸球	1 piece 1 個
1.5 mL microcentrifuge tube 1.5 mL 微量離心管	2 pieces 2 支
Microcentrifuge rack 微量離心管架	1 piece 1 個
15 mL Falcon tube 15 mL 大離心管	4 pieces 4 支
Cuvette rack 分光比色管架	1 piece 1 個
Capillary tube 毛細管	2 pieces 2 支
Calculator 計算機	1 piece 1 個
A 4 papers for calculating 計算紙	1 Set 1 組
Gloves 手套	3 pairs 3 雙
Tissue papers 衛生紙	5 pieces 5 張
Pencil and sharpener	1 piece

鉛筆及削鉛筆器	1 組
Ruler 直尺	1 piece 1 支
Marker pen 簽字筆	1 piece 1 支
Mask 口罩	1 piece 1 個
Plastic goggle 護目鏡	1 pairs 1 付
Waste container 廢棄瓶	1 piece 1 個

Experiment 2. Plant anatomy 植物解剖

Name 名稱	**Quantity** 數量
4 stems of different plant species labelled as SC, SD, SE and SF. Each species include 2 samples 4 種不同植物的莖，分別標示為SC, SD, SE 及 SF，每種有兩份樣本	8 pieces 8 個
Microscope 顯微鏡	1 piece 1 台
Lanceolate needle 探針 (不鏽鋼長針)	1 piece 1 支
Glass Slide 載玻片	10 pieces 10 片
Glass cover slip 蓋玻片	10 pieces 10 片
Filter paper 濾紙	20 pieces 20 張
Razor blade 雙面刀片	2 pieces 2 片
12% bleach solution 12% 漂白溶液	20 mL in bottle 20 mL 於瓶中
3% HCl solution 3% 鹽酸溶液	20 mL in bottle 20 mL 於瓶中
7.5% carmine solution 7.5% 洋紅溶液	20 mL in bottle 20 mL 於瓶中
1.5% green methyl solution 1.5% 甲基綠溶液	20 mL in bottle 20 mL 於瓶中
Distilled water 蒸餾水	20 mL in bottle 20 mL 於瓶中
Timer 碼表	1 piece 1 個
Marker pen 簽字筆	1 piece 1 支
Carrot slice (serves as a cutting board) 紅蘿蔔片 (作為切片板)	1 piece 1 片

Experiment 3. Identification of plant species and make the data matrix
實驗 ***3.*** 鑑定植物種類並建置數據矩陣

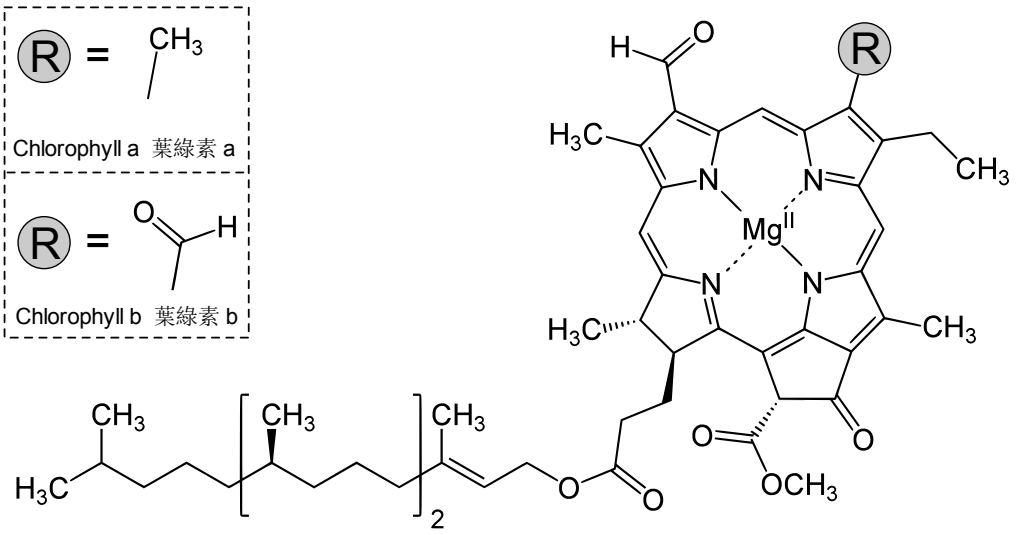
Names 名稱	**Quantity** 數量
5 floral specimen in 70% ethanol labelled as sample PG, PH, PI, PJ, PK. Two flowers for each specimen 5 種花的標本(浸於70% 酒精中) 分別標示為 PG, PH, PI, PJ, PK，每種有2份	5 tubes 5 管
Microscope 顯微鏡	1 piece 1 台
Carrot slice (serves as a cutting board) 紅蘿蔔片 (作為切片板)	1 piece 1 片
Magnifier glass 放大鏡	1 piece 1 支
Pointed needle 指針	1 piece 1 支
Lanceolate needle 探針 (不鏽鋼長針)	1 piece 1 支
Glass slide 載玻片	5 pieces 5 片
Cover slip 蓋玻片	5 pieces 5 片
Forceps 鑷子	1 piece 1 支
Razor blade 雙面刀片	2 pieces 2 片
Filter paper 濾紙	5 pieces 5 張
Mask 口罩	1 piece 1 個
Marker pen 簽字筆	1 piece 1 支
Distilled water 蒸餾水	1 bottle 1 瓶

EXPERIMENT 1. LEAF PIGMENT ASSAY (30 POINTS)
實驗 **1.** 葉片色素分析 **(30** 分**)**

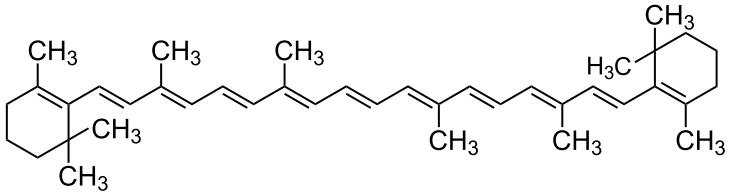
Introduction 前言

Acclimatization to different light intensities involves changes in several physiological characteristics. Leaves exposed directly to sunlight (sun leaves) show differences in leaf structure and their pigment compositions compared with leaves grown under canopy condition (shade leaves). This acclimatization of leaves can be recognized by qualitative and quantitative identification of leaf pigments.
植物對不同光強度的馴化適應，可有多種生理特徵的改變。直接受陽光曝曬的葉片(稱為陽性葉)，相較於在樹冠層下方的葉片(稱為陰性葉)，顯現出不同的葉片構造以及色素組成。這葉片的馴化適應現象可經由葉片色素的定性特性與定量特性上獲得驗證。

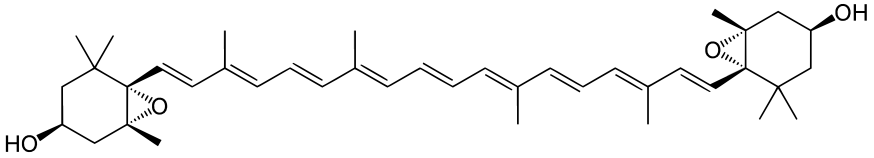
Thin layer chromatography (TLC) is a technique for separating and analyzing the different pigments in the mixture. Leaf pigments including chlorophyll a, chlorophyll b, carotenoids and xanthophylls (violaxanthin, neoxanthin) (see formulas below) can be visualized on TLC plates. To determine the amount of each pigment, leaf extract is quantified by using spectrophotometry at different wavelengths.
薄層色層分析(TLC) 可用以將色素混合液分析出不同色素。在TLC板上可見的葉片色素包括葉綠素a、葉綠素b、類胡蘿蔔素及葉黃素(如violaxanthin, neoxanthin) (各色素的化學結構式如下所示)。欲確定各色素的量，可藉由分光光度計在不同波長下去量測葉片萃取液而得。



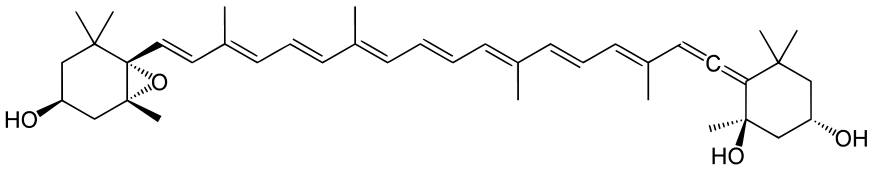
Chlorophyll a and b 葉綠素 a 及 b



b- carotene b-胡蘿蔔素

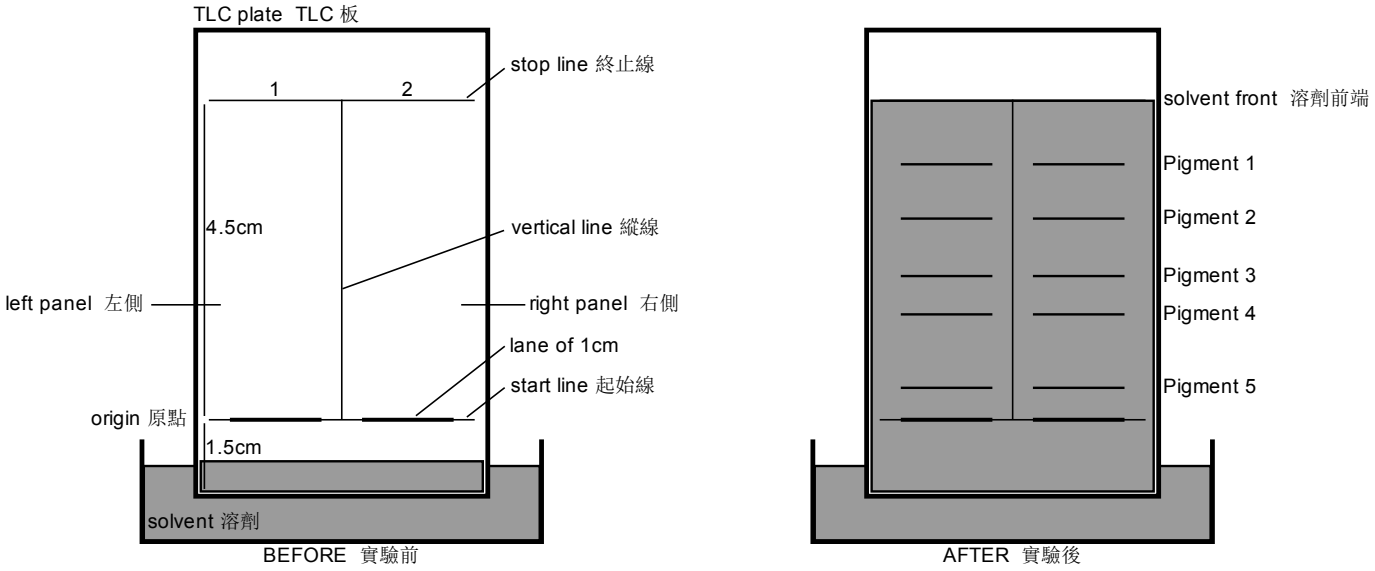


Violaxanthin



Neoxanthin

In this experiment, soybean plants are grown under either sunlight condition or canopy condition to collect leaf samples for qualitative and quantitative analyses of leaf pigments.
本實驗中，大豆植株先分別在陽光下或樹冠層下方生長，然後採集其葉片來做色素之定性與定量分析。



Thin layer chromatography of the plant extract

Spectrophotometer 分光光度計

Experiment procedure
實驗步驟

1. Grind each leaf sample using a separate mortar and its pestle with 2 mL 95% ethanol into a fine mixture. Add a further 5 mL of 95% ethanol to the mixture, and continuously grind to a homogeneous mixture. Transfer the mixtures onto separate filter papers placed into the funnel. Collect the extract into a labeled 15 mL Falcon tube up to 5 mL resulting in extract A and extract B.
用不同的研缽及杵，先以 2 mL的95% 酒精，來研磨兩種葉片至細末混合液，再加入5 mL的 95% 酒精持續磨成均質狀的混合液。將此混合液倒入裝有濾紙的漏斗中過濾，收集濾液於標示 15 mL 的大離心管中，體積達 5 mL，分別得到萃取液A及萃取液B。
2. Transfer 0.5 mL of each extract into newly labeled 15 mL Falcon tubes.
從兩種萃取液中，各取0.5 mL 至新的標示15 mL之大離心管中。
3. Dilute each extract to 5 mL with 95% ethanol and mix the solution gently.
用95% 酒精稀釋至5 mL，並混合均勻
4. Transfer the diluted extracts A and B to the labeled cuvette A and B, respectively. Measure absorbance at 649 and 664 nm for both cuvette A and B. (*Raise your green card when your cuvettes are ready. The assistants will take your samples to measure and give absorbance values back to you. While waiting for the measurement, you should continue with the next steps of the experiment*).
將稀釋後的萃取液A及萃取液B倒入光電比色管A及B中，兩管皆要測 649 及 664 nm 兩種波長下的數值。
*(*當你完成此兩個光電比色管之操作後，舉起綠卡，助理會把你的樣本拿去測量，然後把讀取後的數值還給你。在等候拿回這測量值的同時，你應該繼續下面的步驟。*)*
5. Using a ruler and pencil, lightly draw across the TLC plate 1.5 cm from its bottom edge to make a start line. Place a mark 4.5 cm from the start line to determine the stop line . Lightly draw a vertical line to divide the TLC plate into 2 panels: left panel and right panel. Very lightly draw a 1cm line in the center of the left panel as well as right panel of the start line
for indicating loading point.
直尺及鉛筆在TLC板上距離底邊1.5 cm處輕輕畫出起始線，然後從起始線量4.5 cm處畫出終止線。在TLC板的中間輕畫一條縱線而分成左右兩側。然後在左右兩側的起始線中央處分別輕畫出1 cm 的線，作為點色素的位置(如上圖)。
6. Transfer approximately 0.5 mL of extract A (without dilution) into a 1.5 mL centrifuge tube. Use a glass capillary tube to take extract A from centrifuge tube and lightly load onto the lane extract A along start the 1 cm line of the left panel. Allow the solvent to dry slightly and apply pigmentsthe pigment again up to 10 times. Similarly load the positive control 10 times onto the lane along start line of right panel of TLC plate.
從萃取液A (未稀釋者)取大約0.5 mL置入的1.5 mL 離心管中，用毛細管從離心管中取出萃取液A，並輕輕滴在左側起始線上的1 cm 線處，讓溶劑略乾後再滴加至少10次。然後同法將正對照組滴在右側10次。
7. Let the plate dry for approximately 1 minute at room temperature. Put the plate into the TLC bottle containing a shallow pool of chromatography solvent and close the lid (the pigment area on the plate must not be in contact with the chromatography solvent). As the eluent reaches the stop line, remove the TLC plate immediately from the TLC bottle. (*Raise your* **GREEN card***, the assistant will take a photograph of your TLC plate result for grading*). **6 points** will be graded to your photo of TLC plate.
在室溫下，讓TLC板乾燥約1分鐘，將此板放入裝有薄層色層分析溶劑的TLC瓶中，蓋上蓋子(色素點不能浸到溶劑)。當展開溶劑到達終止線，立刻將TLC板取出，(舉起綠卡，助理會將你的結果拍照，以便評分)。此結果照片會占**6** 分。

Answer following questions in the <u>Answer sheet</u>
在<u>答案紙</u>上回答下列問題

Q.1.1 (10 POINTS)

Record the absorbance values into a table in **Answer sheet**. Calculate concentrations of chlorophyll a (Chl a), chlorophyll b (Chl b), total chlorophyll (Total Chl) according to the following formulae (Lichtenthaler, 1987). Calculate the ratios of chlorophyll a to b for extract A, extract B (to 2 decimal points).
將分光光度計所測得的數值記錄於答案紙的表格中。根據以下公式計算葉綠素a (Chl a)、葉綠素b (Chl b)、總葉綠素(Total Chl) 。分別計算萃取液A及B的葉綠素a/b比值 (至小數點第二位)。

$$\text{Chl a (mg/L)} = -5.19 * (A_{649}) + 13.36 * (A_{664})$$
$$\text{Chl b (mg/L)} = 27.43 * (A_{649}) - 8.12 * (A_{664})$$
$$\text{Total Chl (mg/L)} = 22.24 * (A_{649}) + 5.24 * (A_{664})$$

Q.1.2. (2 POINTS)

Indicate in the **Answer sheet** if each of the following statements is True or False by using this mark ✓
在答案紙上，確定下列敘述的正確或錯誤，以 ✓ 作記

A Leaves used for extract A are generally thicker than those of extract B
相較於萃取液 B者，萃取液 A 的葉片通常較厚

B Leaves used for extract A are more sensitive to photoinhibition
萃取液 A 的葉片對光抑制作用較敏感

C Extract A is derived from shaded leaves
萃取液 A 是來自陰性葉片

D Leaves for extract A have lower light compensation point than that of leaves for extract B
相較於萃取液 B者，萃取液 A 的葉片有較低的光補償點

Q.1.3. (6 POINTS)

After taking the photograph of your TLC plate, place it back into the small plastic bag. Seal the top and staple it to your **Answer sheet.**
TLC板被拍照後，將TLC板放入小塑膠袋中並封口，把它釘在你的答案紙上。

Q.1.4. (10 POINTS)

Calculate the RF values according to the following formula and determine the name of each pigment. The ***distance travelled by pigment*** is measured from the start line to the horizontal and vertical centre of the pigment band. The **distance travelled by solvent** is measured from the start line to the solvent front.
根據以下的公式計算RF值，並確定每種色素的名稱。色素移動的距離是從起始線至該色素帶的橫向及縱向交點，溶劑移動的距離是從起始線至溶劑跑到的前端。

$$Rf = \frac{\text{Distance travelled by pigment 色素移動距離}}{\text{Distance travelled by solvent 溶劑移動距離}}$$

*no band = no score
沒有色素帶 = 沒有分數

Q.1.5. (2 POINTS)

Indicate in the **Answer sheet** if each of the following statements is True or False by using this mark ✓
在答案紙上，確定下列敘述的正確或錯誤，以 ✓ 作記

A Chlorophyll a and chlorophyll b show different Rf values due to their molecular weight.
葉綠素a 及葉綠素 b 有不同的 Rf 值，是因為其分子量不同

B Rf value of chlorophyll and b-carotene are different owing to their different polarity
葉綠素及 b-胡蘿蔔素的 Rf 值不同，是因為其極性不同

C Speed of pigment movement mainly depends on interaction with stationary phase on TLC plate.
色素移動速率主要受到TLC板上的固定相的交互作用

D In the chromatography experiment, n-hexane and acetone are combined as chromatography solvents. These two solvents are used in order to enhance the solubility of different pigments.
在色層分析實驗中， n-hexane and acetone 混合而成色層分析溶劑。使用這兩種溶劑可增強不同色素的溶解力。

EXPERIMENT 2. PLANT ANATOMY (31 POINTS)
實驗 2. 植物解剖 (31 分)

Land plants evolved from algae nearly 500 million years ago. Many new features facilitating survival and reproduction on dry land emerged after land plants diverged from their algal relatives. In land plants, the stem is one of the most important organs that supports leaves and reproductive organs by means of mechanical strengthening and transportation of water, minerals and organic compounds. These functions are carried out by the vascular system, including xylem and phloem, which are present in certain plants. The inner structure (anatomy) of plant stem sections can be observed through microscope.
植物(Land plants)大約是在5億年前由藻類演化而成。有許多與在乾燥的陸地上存活及生殖有關的新特性，是在植物從其藻類近親分岐出來之後才衍生而得。在植物中，莖是最重要的器官，其藉由機械強化、以及水、礦物質與有機化合物的運送來支持葉片及生殖器官。這些功能是由維管束系統來維持，其在某些植物中包括木質部與韌皮部。我們可藉由顯微鏡觀察植物莖切片的內部構造(解剖)。

In this task, you will perform stem sectioning of four plants and observe anatomical traits. Based on characteristics of vascular system, a phylogenetic tree representing the evolutionary trend of vascular system and the relationship between given plant taxa, can be generated.
在本部分，你將對四種植物作徒手切片，並觀察其解剖特徵。根據維管束系統的特性，可建構出一個代表維管束系統的演化趨勢及特定植物類群的關係之親緣關係樹。

Experimental procedure
實驗步驟

1. Slice samples using a razor blade. Make cross-sections as thin as possible.
   用刀片作徒手切片，盡可能切出橫切薄片。
2. Transfer sections onto a glass slide. Add drops of bleach solution to fully cover the sections and let stand for 2 minutes. Use filter paper to remove excess bleach solution from the sections.
   將切片移至載玻片上，加數滴漂白水淹過切片，並靜置約 2 分鐘。利用濾紙移除切片上多餘的漂白水
3. Add drops of HCl solution to fully cover the sections and let stand for 30 seconds. After that, use filter paper to remove excess HCl solution from the sections.
   加數滴鹽酸溶液至淹過切片，並靜置約30秒。然後利用濾紙移除切片上多餘的鹽酸溶液
4. Add drops of water to wash the sections. After that, use filter paper to remove water from the sections.
   加數滴水清洗切片，然後利用濾紙移除切片上多餘的水
5. Add drops of carmine solution to stain the sections for 3 minutes. Use filter paper to remove carmine solution.
   加數滴洋紅溶液來染切片約 3 分鐘，然後利用濾紙移除洋紅溶液
6. Add drops of green methyl solution to fully cover the sections and stain for 30 seconds. After that, use filter paper to remove excess green methyl solution.
   加數滴甲基綠溶液至淹過切片，染色約30秒。然後利用濾紙移除切片上多餘的甲基綠溶液
7. Add drops of water on the sections, cover the sections with a glass cover slip, use filter paper to remove excessive water, and then observe under a microscope.
   加數滴水在切片上，蓋上蓋玻片，利用濾紙移除切片上多餘的水，然後在顯微鏡下觀察

Answer these following questions into the <u>Answer Sheet</u>:
在<u>答案紙</u>上回答下列問題

Q.2.1. (8.0 POINTS)

Which of these following tissues are present in each plant sample?
在每種植物樣本中，具有下列哪些組織?

Mark ✓ for tissues present and × for tissues absent in observed samples in the table in the **Answer sheet**
在答案紙的表格中，具有此組織則標示為 ✓ ，沒有此組織則標示為 ×

Q.2.2. (6.4 POINTS)

Use the plant sections to observe 4 stem anatomical characters and states whether they are absent (0) or present (1). Write 0 or 1 of each character to the data matrix in the **Answer sheet** below. The data of outgroup taxon SH are already given.
用植物切片觀察 4 種植物的莖之解剖特徵，決定其特徵狀態: 沒有則標示為 "0" ； 具有則標示為 "1"。在答案紙的矩陣中填入每個特徵的狀態為 0 或 1，外群物種(SH)的數據已填入。

A phylogenetic tree (shown in Fig. below) of four experimental plant species and one given species (SH) is generated using parsimony method, based on the above data matrix. The primitive character state (state 0) is hypothesized to be the same as the state in the taxon SH.
四種本實驗所用的植物種類及一種已知物種 (SH) 的親緣關係樹(下圖所示)是利用簡約法將上面的矩陣所建構而成。假設原始特徵狀態 (0) 與物種 (SH) 的狀態相同。

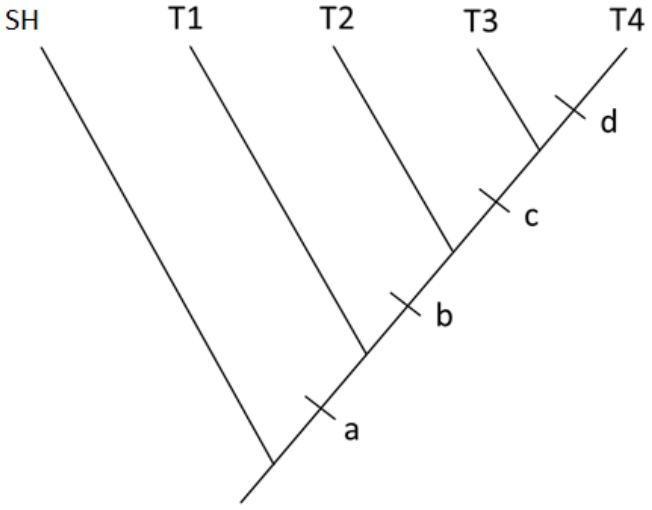


Fig. Phylogenetic tree of 5 species (Taxon: T)
圖: 五物種的親緣關係樹 *(分類群: T)*

Q.2.3. (8.0 POINTS)

Using the result from Q.2.2, determine the stem character (C1 to C4) corresponding to the character (a to d) in the phylogenetic tree, and define the position of each experimental plant species (SC to SF) corresponding to its taxon (T1 to T4) in the phylogenetic tree.
利用 Q.2.2 的結果，對應親緣關係樹上的特徵(a to d)，來確定莖的特徵 (C1 to C4)，並確定每種實驗植物物種 (SC to SF) 在親緣關係樹上的對應位置(T1 to T4)。

- Write down the stem character (C1 to C4) corresponding to the character (a to d) in the phylogenetic tree:
  對應親緣關係樹上的特徵(a to d)，寫下莖的特徵 (C1 to C4)

Q.2.4. (6.0 POINTS)

- Write down the name of plant species (SC to SF) corresponding to its taxon (T1 to T4) in the phylogenetic tree:
  對應親緣關係樹上的位置(T1 to T4)，寫下每種植物物種的名稱 (SC to SF)。

Q.2.5. (1.0 POINT, 0.25 POINTS EACH)

Refer to the diagram of one vascular bundle on the **Answer Sheet** and label the metaxylem (1), phloem (2), protoxylem (3) and sclerenchyma (4) into the open boxes:
在答案紙上的維管束示意圖上的空格中標示編號:
後生木質部(1)、韌皮部 (2)、早生木質部 (3) 以及厚壁組織 (4)

Q.2.6. (1.6 POINTS)

Indicate in the **Answer sheet** if each of the following statements is True or False by using this mark ✓
在答案紙上，確定下列敘述的正確或錯誤，以 ✓ 作記

A The stem of plant SC could not transport water as efficiently as plants SD and SE
植物 SC 的莖之輸水效能不如植物 SD 及 SE

B The abundance of sclereid in plant SD makes the stem hard.
植物 SD 的莖具有大量的厚壁細胞，使其莖堅硬

C The stem diameter of plant SE does not increase continuously during plant development because sclerenchyma restricts the development of vascular bundles.
植物 SE 莖的直徑不會在植物發育期間持續加粗，是因為厚壁組織限制了維管束的發育

D The sclerenchyma ring below the epidermis strengthens the stem of plant SF.
在表皮以內的一圈厚壁組織可使植物 SF 的莖強壯

EXPERIMENT 3. IDENTIFICATION OF PLANT SPECIES AND MAKE DATA MATRIX (30POINTS)

實驗 **3** 鑑定植物種類並建置數據矩陣

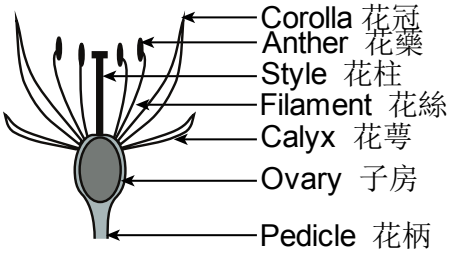
Introduction 前言

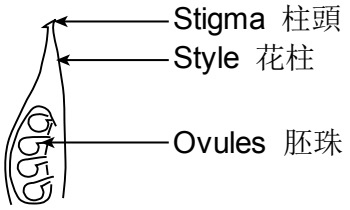
Flower structures are exceedingly varied but they are useful for plant species identification.
花的構造相當多變化，但可用於植物種類之鑑定。

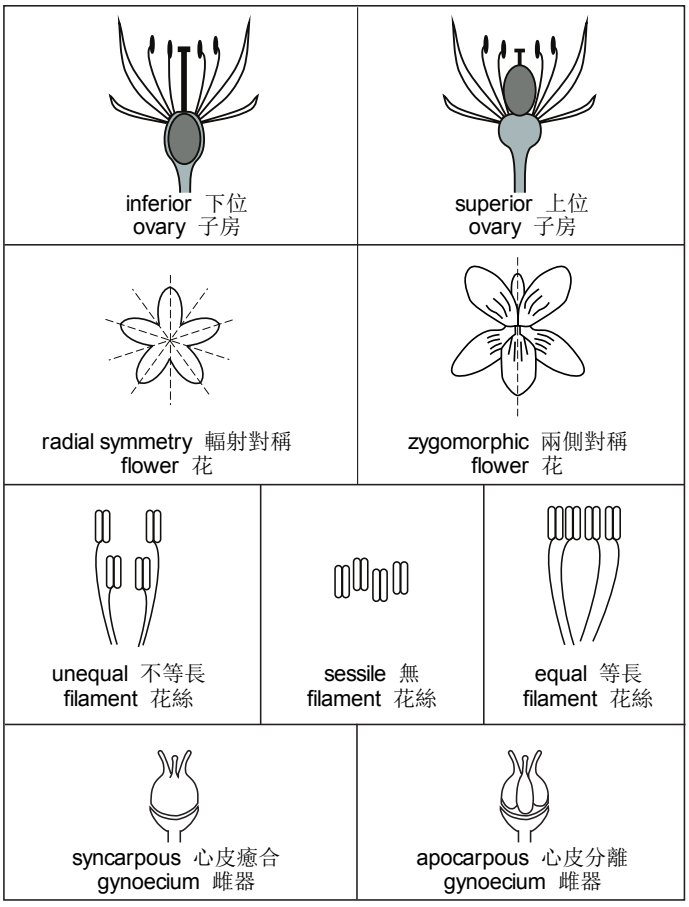
In this task, you will identify morphological and anatomical traits of five given floral samples (sample PG-PK) and answer the questions in the **Answer sheet**. Based on the given dichotomous key and using observed morphological and anatomical characteristics you have to name samples PG-PK. Make data matrix for given samples.

此部分中，你將鑑定五種花的標本(標本 PG-PK) 之形態及解剖特徵，並在答案紙上回答問題。根據所提供的檢索表以及所觀察到的形態及解剖特徵，你必須指出標本 PG-PK 的名稱，並建置數據矩陣。

To help understand the terminology used below figures:
利用下列的圖示來了解各專有名詞。







Experimental procedure
實驗步驟

3.1. Flower symmetry 花的對稱

- Use the forceps to take each sample out of the falcon tube onto a glass slide. Close the tube to avoid ethanol vapor in the room. Use filter paper to remove excess ethanol.
  用鑷子將每個標本從大離心管中取出，放在載玻片上。鎖緊管蓋以免酒精揮發至房間中。使用濾紙吸除多餘的酒精。
- Handle the flower specimens carefully, as you need the given plant material for all your observations.
  小心操作花的標本，你將需要這些材料來完成所有觀察

Q.3.1. (2.5 POINTS)

Distinguish flower symmetry in each sample and fill "✓" in the table if the flower is radial symmetrical or zygomorphic in the **Answer sheet**
區分每種花的對稱性，並在答案紙的表格中，填入"✓" 以顯示其為輻射對稱或兩側對稱。

3.2. Number and characteristics of floral parts
花的各組成部分之數目與特徵

- Use the pointed needle, lanceolate needle, razor blade and magnifier glass to analyze in turn the calyx, corolla, androecium and gynoecium for all samples provided.
  用細針；探針；刀片及放大鏡來確定所有標本的花萼、花冠、雄器及雌器
- Observe all samples carefully and complete Q.3.2 and Q.3.3.
  仔細觀察所有標本並完成 Q.3.2 及 Q.3.3.

Q.3.2. (4.5 POINTS)

Determine the number of calyx or calyx lobes, corolla lobes, stamens in each sample and put these numbers in table in the **Answer sheet**
確定每種標本的萼片或花萼裂片、花冠裂片、雄蕊的數目，在答案紙中填入其數目

Q.3.3. (9.0 POINTS, 0.3 POINTS PER BOX)

Determine the characteristics of calyx, corolla, filament, and gynoecium in each sample and fill "✓" in the table if with characteristic, "x" if without characteristics in the **Answer sheet**.
確定每種標本之花萼、花冠、花絲與雌器的特徵，並在答案紙的表格中填入"✓"代表有此特徵，填入 "x" 代表沒有此特徵

- Put the gynoecium on the carrot piece, use razor blade to make cross sections of the ovary as thin as possible on one flower and cut along the ovary on the other flower of the same sample PG, PI, PJ (sample PH, PK are already given). Put the sections on the glass slide, add one drop of water on the section, cover with a cover slip. Observe the sections under the microscope.
將雌器放在胡蘿蔔片上，用刀片盡可能將一朵花的子房切成橫切薄片，將同種標本(PG, PI, PJ)的另一朵花縱切 (標本PH, PK的特徵已提供)，將切片放在載玻片上，加一滴水，蓋上蓋玻片、在顯微鏡下觀察其特徵。

Q.3.4. (3.0 POINTS)

Determine the number of locules and ovules per locule in each sample and put these numbers in the table in the **Answer sheet**.
確定每種標本之心皮以及每個心皮的胚珠數目，並將數目填入答案紙的表格中。

3.3. Identify plant species 鑑定植物種類

Dichotomous key to the species: the key was determined by the presence or absence of characteristic. Read the dichotomous key carefully, if you can't find the characteristic in the first line, please move to the second line in the same number.
鑑定物種的檢索表是藉由特徵的有無來決定，仔細閱讀檢索表，使用檢索表的方法--若你不能在第一行對應到該特徵，就移至同一號碼的第二行。

1	Filaments **equal or sessile** 花絲等長或無花絲	Go to 2
	Filaments **unequal** 花絲不等長	Go to 6
2	Ovary **more than 2**-loculed 子房有**2**室**(**心皮**)**以上	Species **ta**
	Ovary **2**-loculed 子房 **2** 室(心皮)	Go to 3
3	Number of ovule per locule as **1** 每心皮有 **1** 個胚珠	Go to 4
	Number of ovule per locule **more than 1** 每心皮有 1 個以上的胚珠	Go to 5
4	Corolla **with** hair in abaxial 花冠的背軸面有毛	Species **tb**
	Corolla **without** hair in abaxial 花冠的背軸面無毛	Species **tc**
5	Corolla **with** hair in abaxial, **syncarpous** gynoecium 花冠的背軸面有毛、雌器之心皮癒合	Species **td**
	Corolla **without** hair in abaxial, **apocarpous** gynoecium 花冠的背軸面無毛、雌器之心皮分離	Species **te**
6	Corolla **4-5** lobed 花冠 **4-5** 裂片	Go to 7
	Corolla **more than 5** lobed 花冠 **5** 裂片以上	Species **tm**
7	Number of ovule per locule only **1** 每心皮只有 **1** 個胚珠	Go to 8
	Number of ovule per locule **more than 1** 每心皮有 1 個以上的胚珠	Go to 9
8	Calyx without hair in abaxial 花萼的背軸面無毛	Species **tf**
	Calyx with hair in abaxial 花萼的背軸面有毛	Species **tg**
9	Corolla **with** hair in abaxial; ovary **inferior** 花冠的背軸面有毛、子房下位	Species **th**
	Corolla **without** hair in abaxial; ovary **superior** 花冠的背軸面無毛、子房上位	Species **tk**

Q.3.5. (6.0 POINTS)

Using the dichotomous key, identify the name of the species for samples PG-PK, choose and fill the name of species (ta, tb, tc, td, te, tf, tg, th, tk, tm) in the table in the **Answer sheet.**
利用檢索表鑑定標本PG-PK之物種名稱 (ta, tb, tc, td, te, tf, tg, th, tk, tm)， 並填入答案紙的表格中

3.4. MAKE DATA MATRIX 建置數據矩陣

Q.3.6. (5.0 POINTS)

Write down the correct character state of each character to the data matrix in the table in the **Answer sheet.**
在答案紙的表格中，填入正確的特徵狀態

End of practical Exam 1 實作 **1** 結束

Country:
Student Code:

27th International Biology Olympiad

July 17-23, 2016
Hanoi, Vietnam

Practical Exam 1

PLANT ANATOMY AND PHYSIOLOGY

ANSWER SHEET 答案紙

Total points: 91
Duration: 90 minutes

Q.1.1 (10 POINTS)

Extract	A_{649}	A_{664}	Chl a	Chl b	Total Chl	Ratio of Chl a/b
A						
B						

Q.1.2. (2 POINTS)

	True 正確	False 錯誤
A		
B		
C		
D		

Q.1.3. (6 POINTS)

Attach your TLC plate here 將TLC 板釘於此

Q.1.4. (10 POINTS)

Pigment band (from stop to start line according to TLC band) 色素帶 (TLC板上的色素帶，從終止線至起始線)	**Rf values of 5 main pigments** (to 2 decimal points) **5**種主要色素的**Rf**值**(**至小數點第**2**位**)**	**Pigment name** 色素名稱
1		
2		
3		
4		
5		

Q.1.5. (2 POINTS)

	True 正確	False 錯誤
A		
B		
C		
D		

Q.2.1. (8.0 POINTS)

Tissue 組織	**SC**	**SD**	**SE**	**SF**
Cork 木栓組織				
Distinct cortex and pith 明顯可區分出皮層及髓				
Endodermis 內皮				
Vascular cambium 維管束形成層				
Vascular bundles are enclosed by a sheath of sclerenchyma 維管束被厚壁組織所構成的鞘圍住				

Q.2.2. (6.4 POINTS)

Character 特徵	**SC**	**SD**	**SE**	**SF**	**SH**
C1. Vascular tissue 維管束組織					0
C2. Vascular system consisting of collateral vascular bundles 維管束系統由並列維管束所組成					0
C3. Collateral vascular bundles scattered in parenchyma 並列維管束分散在薄壁組織中					0
C4. Stele has pith or vascular bundles are separated by parenchyma 中柱具有髓或維管束被薄壁組織隔開					0

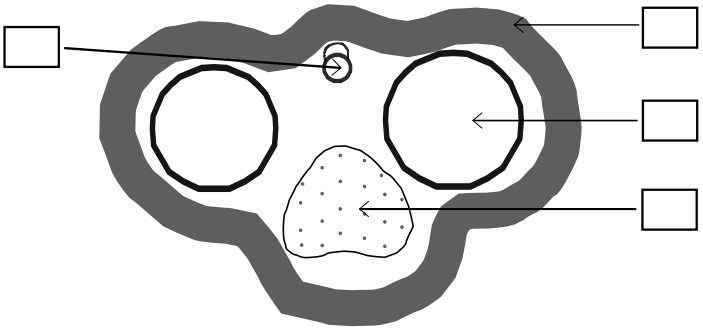
Q.2.3. (8.0 POINTS)

Character (a to d) in the phylogenetic tree 親緣關係樹上的特徵(a to d)	**Stem anatomical character (C1 to C4)** 莖的特徵 (C1 to C4)
a	
b	
c	
d	

Q.2.4. (6.0 POINTS)

Taxon in the phylogenetic tree 親緣關係樹上的分類群	**Plant species (SC to SF)** 植物物種**(SC to SF)**
T1	
T2	
T3	
T4	

Q.2.5. (1.0 POINT, 0.25 POINTS EACH)



Q.2.6. (1.6 POINTS)

	True 正確	False 錯誤
A		
B		
C		
D		

Q.3.1. (2.5 POINTS)

Flower symmetry 花的對稱性	**Sample PG**	**Sample PH**	**Sample PI**	**Sample PJ**	**Sample PK**
Radial symmetric 輻射對稱					
Zygomorphic 兩側對稱					

Q.3.2. (4.5 POINTS)

Number unit 數目單位	**Sample PG**	**Sample PH**	**Sample PI**	**Sample PJ**	**Sample PK**
Number of sepal or calyx lobes 萼片或花萼裂片數目					
Number of corolla lobes 花冠裂片數目					
Number of stamens 雄蕊數目					

Q.3.3. (9.0 POINTS, 0.3 POINTS PER BOX)

Characteristics 特徵	**Sample PG**	**Sample PH**	**Sample PI**	**Sample PJ**	**Sample PK**
Calyx with hair in abaxial 花萼背軸面有毛					
Corolla with hair in abaxial 花冠背軸面有毛					
Filaments equal 花絲等長					
Filaments sessile 無花絲					
Ovary superior 子房上位					
Syncarpous gynoecium 心皮癒合之雌器					

Q.3.4. (3.0 POINTS)

Number unit	**Sample PG**	**Sample PH**	**Sample PI**	**Sample PJ**	**Sample PK**
Number of locules 心皮數		4			4
Number of ovules per locule 每個心皮的胚珠數		1			1

Q.3.5. (6.0 POINTS)

	Sample PG	**Sample PH**	**Sample PI**	**Sample PJ**	**Sample PK**
Name of species 物種名稱					

Q.3.6. (5.0 POINTS)

Character state 特徵狀態	**Sample PG**	**Sample PH**	**Sample PI**	**Sample PJ**	**Sample PK**
Flower radial (0) and flower zygomorphic (1) 輻射花(0)及兩側花(1)					
Calyx without hair in abaxial (0) and with (1) 花萼背軸面無毛(0)及有毛(1)					
Corolla without hair in abaxial (0) and with (1) 花冠背軸面無毛(0)及有毛(1)					
The number of stamens is 5 and more than 5 (0) and under 5 (1) 雄蕊數**5** (0)及**5**以上 (1)					
Filament equal (0) and not (1) 花絲等長(0)及 不等長 (1)					
Filaments sessile (0) and not (1) 無花絲 (0) 及有花絲(1)					
Superior ovary (0) and inferior ovary (1) 子房上位 (0) 及子房下位 (1)					
Apocarpous gynoecium (0) and syncarpous gynoecium (1) 雌器心皮分離 (0) 及雌器心皮癒合 (1)					
The number of locules is 3 and more 3 (0) and under 3 (1) 子房 **3**室以上 (0) 及 **3**室以下(1)					
The number of ovules per locule more than 1 (0) and number of ovules per locule as 1 (1). 每心皮**1**個胚珠以上 (0) 及**1**個胚珠 (1)					