A A A  02:30                          0    Chinese Traditional  ▾  |  TWN-JURY-5  | ➡

# PRACTICAL EXAM 1– PLANT ANATOMY, BIOSYSTEMATICS AND EVOLUTION
# 實作1 植物解剖學、生物系統分類及演化

## INTRODUCTION 簡介

Max. total points 100　滿分為100分
Exam duration 90 minutes　操作時間為90分鐘
six questions　共6題

Land plants constitute a monophyletic lineage of Eucaryotes, that has been extremely successful in adapting to terrestrial habitats. Land plants structure terrestrial ecosystems physically and provide the framework for ecological interactions between all other land-living organisms. In this exam, we take a closer look at the evolution of the key characters, that led to the dominance of land plants on Earth.
演化至陸地上的植物(陸生植物)是由一統稱為Eucaryotes的單系群所組成，且極成功地適應陸地的環境。陸生植物是構成陸上的生態系且提供所有在陸上生活的生物間的生態交互作用的網絡。本實作中，我們將進一步檢視一些導致植物在陸上佔優勢的關鍵特徵之演化。

Purpose of exam: Plant Identification , morphological description and reconstruction of ancestral relationships
本實作的目的: 植物鑑定、形態描述及祖先關係的重新建構。

The exam consists of five parts.
本實作包括5的部分

Part 1. Identification of specimens (5 points)
第1部分 標本鑑定(5分)

Part 2. Morphological description (36 points)
第2部分 形態描述(36分)

Part 3. Morphological variation and character matrix coding (29 points)
第3部分 形態變異及特徵矩陣編碼(29分)

Part 4. Mapping character evolution on a phylogenetic tree (21 points)
第4部分 在親緣關係樹上標示對應特徵的演化(21分)

Part 5. Evolution of key characters in land plants (9 points)
第5部分 陸生植物關鍵特徵的演化(9分)

**We suggest you read the entire exam file before you begin the lab work.**
在開始操作此實作之前，建議你先把整個實作內容看完。

# MATERIALS & EQUIPMENT
# 材料及器材

In order to do your lab work, you need the materials listed below. Please, ensure that these materials are available to you. **If anything is missing, contact the exam personnel by raising your pink card immediately – and no later than 15 minutes after the beginning of the exam. Please handle all the materials carefully as they will be used by all your teammates..**
本實作中的材料如下所列。請確認所有材料都有，若有少，請立刻舉起粉紅色卡片通知監考人員，並請在考試的前15分鐘內提出。請小心操作這些材料，因為其他隊友仍將使用這些材料。

5 Herbarium sheets (H1–H5). (Please note that the information included in the lables is not important for identifying the specimens to species) IMPORTANT: PLEASE DO NOT WRITE ON THE NEWSPAPER PAGES PROTECTING THE PLANTS - IF YOU DO IT WILL EXPEL YOU FROM THE EXAM.
5張壓乾的蠟葉標本(H1–H5)。(注意: 標本上的標籤資料對於鑑定此物種並不重要)
重要: 不可在所提供保護植物的報紙上做記號，否則將視為作弊。

5 Photos of live plants in nature (P1–P5)
5張活體植物的實際照片(P1–P5)

2 Collections of live plants (F1–F2)
2組活體植物(F1–F2)

4 Alcohol-preserved collections of selected plant parts (A1–A4)
4組以酒精固定的選定植物構造(A1–A4)

4 Anatomical sections mounted on microscope slides (M1–M4)
4片解剖切片標本(M1–M4)

1 petri dish
1個培養皿

1 forceps
1支鑷子

1 teasing needle
1支解剖針

1 click-on macro-lens for the tablet
1個平板電腦用的放大鏡

1 touch pen for the tablet
1支平板電腦用的觸控筆

1 microscope
1台顯微鏡

## Others
其他器材
1 sheet with pictures of the included materials ,
1張列出所有器材照片的紙

# 1. IDENTIFICATION OF SPECIMENS (5 POINTS)
## 第1題 鑑定種類(5分)

The materials (see above) belong to eight species of land plants, listed below in alphabetical and numbered order:
上述這些材料歸為8個陸生植物的物種，下列是依屬名的字母順序列出。

1 *Allium ursinum*（Wild garlic）寬葉蒜
2 *Equisetum arvense*（Common horsetail）木賊
3 *Lycopodium annotinum*（Bristly club-moss）杉葉蔓石松
4 *Pinus sylvestris*（Scots pine）歐洲赤松
5 *Pisum sativum*（Garden pea）豌豆
6 *Polypodium vulgare*（Fern）歐亞多足蕨
7 *Polytrichum commune*（Common hair moss）土馬騌
8 *Selaginella kraussiana*（African clubmoss）小翠卷柏

These 8 species represent five major evolutionary lineages of land plants: Mosses (1 species), Lycophytes (2 species), Ferns and their allies (2 species), Gymnosperms (1 species) and Angiosperms (2 species). Notice that *Selaginella kraussiana* will be used throughout this exam as an exemplar species which signifies that some of the answers have already been provided
這8個物種代表5個陸生植物的演化支系: 苔類(1物種)、石松類(2物種)、蕨類及相近類群(2物種)、裸子植物(1物種)及被子植物(2物種)。 注意: 小翠卷柏將在整個實作中用到，且其相關答案已提供當作實例。

🏴 | Q. 1    Identification of specimens
鑑定標本

Node Id: **cb6ffb1a6899c04a2b85ef19**
實作
**Identify each species on the five herbarium sheets as one of the eight species listed above.**
鑑定所提供的**5**份壓乾的蠟葉標本，指出其分別為上述**8**個物種的何者**?**

| | A.URS 寬葉蒜 | E.ARV 木賊 | L.ANN 杉葉蔓石松 | P.SYL 歐洲赤松 | P.SAT 豌豆 | P.VUL 歐亞多足蕨 | P.COM 土馬騌 | S.KRA 小翠卷柏 |
|---|---|---|---|---|---|---|---|---|
| H1 | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| H2 | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| H3 | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| H4 | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| H5 | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |

Node Id: **08d8d6d8ede1990e5d410b9f**
**Identify each species on the five photographs (P1-P5) as one of the eight species listed above.**
鑑定**5**張照片**(P1-P5)**上的物種，指出其分別為上述**8**個物種的何者**?**

| | A.URS 寬葉蒜 | E.ARV 木賊 | L.ANN 杉葉蔓石松 | P.SYL 歐洲赤松 | P.SAT 豌豆 | P.VUL 歐亞多足蕨 | P.COM 土馬騌 | S.KRA 小翠卷柏 |
|---|---|---|---|---|---|---|---|---|
| P1 | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| P2 | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| P3 | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| P4 | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| P5 | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |

Node Id: **e114708fccd51856142add0c**

**Identify each species on the two live plants (F1-F2) as one of the eight species listed above.**

鑑定**2**種活體植物 **(F1-F2)**的物種，指出其分別為上述**8**個物種的何者**?**

| | A.URS 寬葉蒜 | E.ARV 木賊 | L.ANN 杉葉蔓石松 | P.SYL 歐洲赤松 | P.SAT 豌豆 | P.VUL 歐亞多足蕨 | P.COM 土馬騌 | S.KRA 小翠卷柏 |
|---|---|---|---|---|---|---|---|---|
| F1 | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| F2 | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |

Node Id: **0ceb2557de5af19765510b75**

**Identify each species on the four alcohol-preserved specimens (A1-A4) as one of the eight species listed above.**
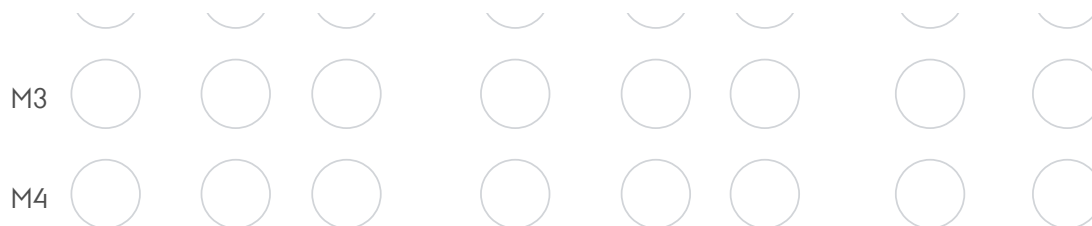
鑑定所提供的酒精固定植物構造**(A1-A4)**的物種，指出其分別為上述**8**個物種的何者**?**

| | A.URS 寬葉蒜 | E.ARV 木賊 | L.ANN 杉葉蔓石松 | P.SYL 歐洲赤松 | P.SAT 豌豆 | P.VUL 歐亞多足蕨 | P.COM 土馬騌 | S.KRA 小翠卷柏 |
|---|---|---|---|---|---|---|---|---|
| A1 | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| A2 | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| A3 | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| A4 | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |

Node Id: **8a04574e6f6c33e6be9de3c4**

**Identify each species on the four anatomical sections (M1-M4) as one of the eight species listed above.**

鑑定所提供的**4**張解剖切片 **(M1-M4)**的物種，指出其分別為上述**8**個物種的何者**?**

| | A.URS 寬葉蒜 | E.ARV 木賊 | L.ANN 杉葉蔓石松 | P.SYL 歐洲赤松 | P.SAT 豌豆 | P.VUL 歐亞多足蕨 | P.COM 土馬騌 | S.KRA 小翠卷柏 |
|---|---|---|---|---|---|---|---|---|
| M1 | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| M2 | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |

M3 ◯ ◯ ◯ ◯ ◯ ◯ ◯ ◯

M4 ◯ ◯ ◯ ◯ ◯ ◯ ◯ ◯

# 2. MORPHOLOGICAL DESCRIPTION (36 POINTS)
# 第2題 形態描述(36 分)

Locate the position of the nine morphological structures (listed below) on your materials and document your identification photographically (An example is shown in Fig. 2.1).
將下列9個形態構造名稱，標示在正確位置，並拍照存證，記下你的鑑定依據，標示方法如圖 2.1所示。

## Morphological structure
形態構造

Anther　花葯

Operculum　萼蓋

Sorus　孢子囊堆

Sporophyll　孢子葉

Microphyll　小葉

Sporangium　孢子囊

Sepal 萼片

Seed
種子

Pollen grain
花粉粒

## Protocol
操作步驟
1. Mount the click-on macro-lens for the tablet onto the camera lens of your tablet.
將平板電腦專用的放大鏡安裝在你的平板電腦的相機鏡頭上

2. Choose one specimen from the materials , in which the relevant structure is represented.
從材料中選擇一個標本，其可適當代表其對應之構造

3. Photograph plant specimen. Photograph only one specimen of each structure.
拍下植物樣片的照片，每個樣本只能上傳一張

4. Indicate with an arrow on the photo the position of the structure (see Fig. 2.1 for an example).
在拍下的照片中標示一個箭頭，指出構造的位置(如圖2.1所示)

5. Upload the photo.
上傳有標示的照片

6. Repeat this procedure (steps 2–5) for the remaining morphological structures.
   重複第2-5步，拍下其餘形態構造。



**Figure 2.1:** *Example of how to mark a structure with an arrow: Calyptra on Polytrichum commune (step 4 in the protocol above)*
圖*2.1:如何在構造上標示箭頭: 土馬騌(Polytrichum commune) 的蒴帽(如步驟4所述)*

Each uploaded photo with an arrow placed at the correct structure earns you 3 points. An additional point is awarded for clarity of the photos. The structure should be, 1) fully represented, 2) fill up the picture frame and, 3) in focus.
每張上傳的照片中若箭頭標示在正確的構造上，則可得3分。照片若清晰，則可再加1分。所拍攝的構造必須(1)具代表性、(2)佔滿拍照範圍、(3)清楚對焦。

Drag-and-drop the blue arrow. The arrow point has to be exactly at the structure in question.
正確製作藍色箭頭，箭頭須正確指在所問的構造上。

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🏳 | Q. 2        Photos of 9 morphological structures (27 points) and clarity  of structure (9 points)
                9張形態構造照片(27 分)以及構造清晰(9 分)

Node Id: **ae769742163251ad17453bff**
     **Anther photo – 3 points**
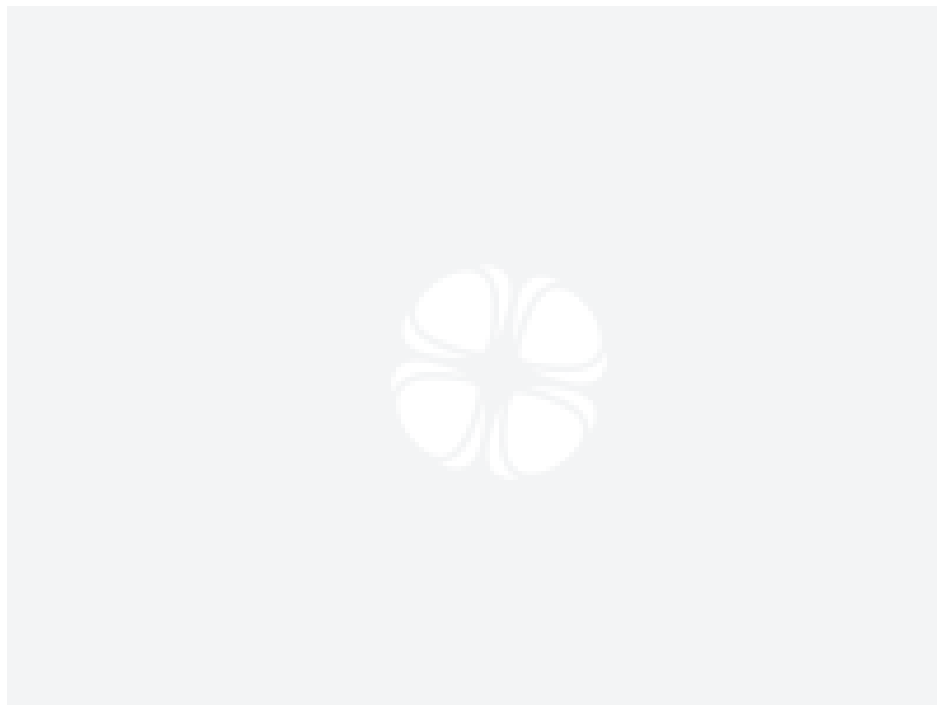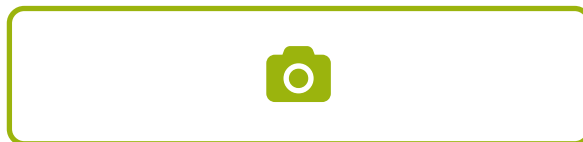     花葯照片 **- 3分**

Node Id: **5d23ad48eb3b665a0e615f5a**
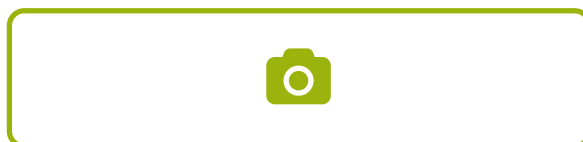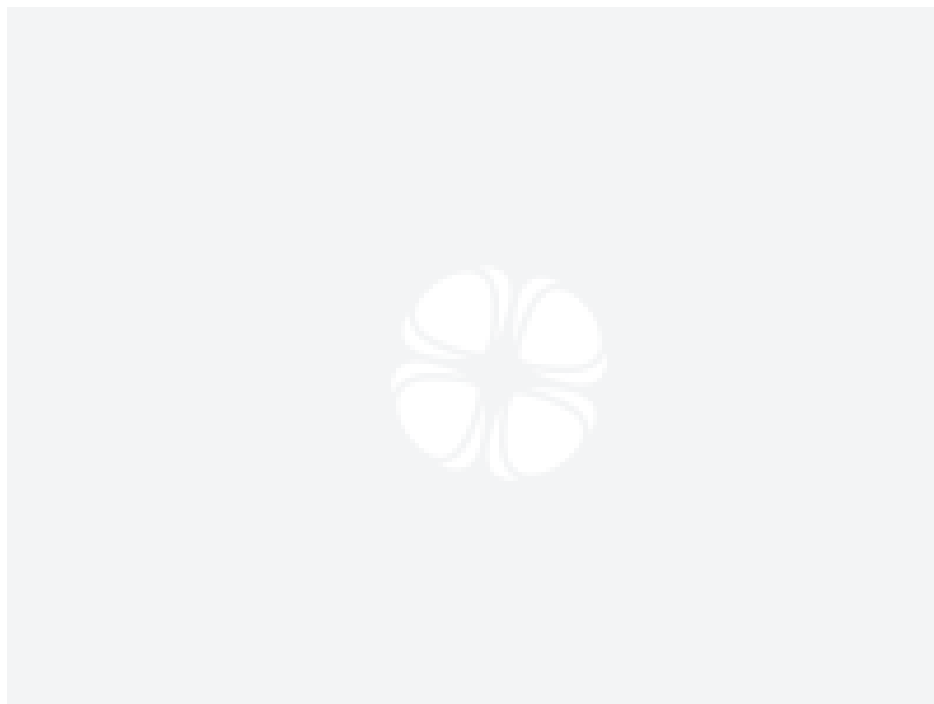   **Operculum photo – 3 points**
   蒴蓋照片 **- 3**分

Node Id: **e43cd2801bef0ea45452db2b**
   **Sorus photo – 3 points**
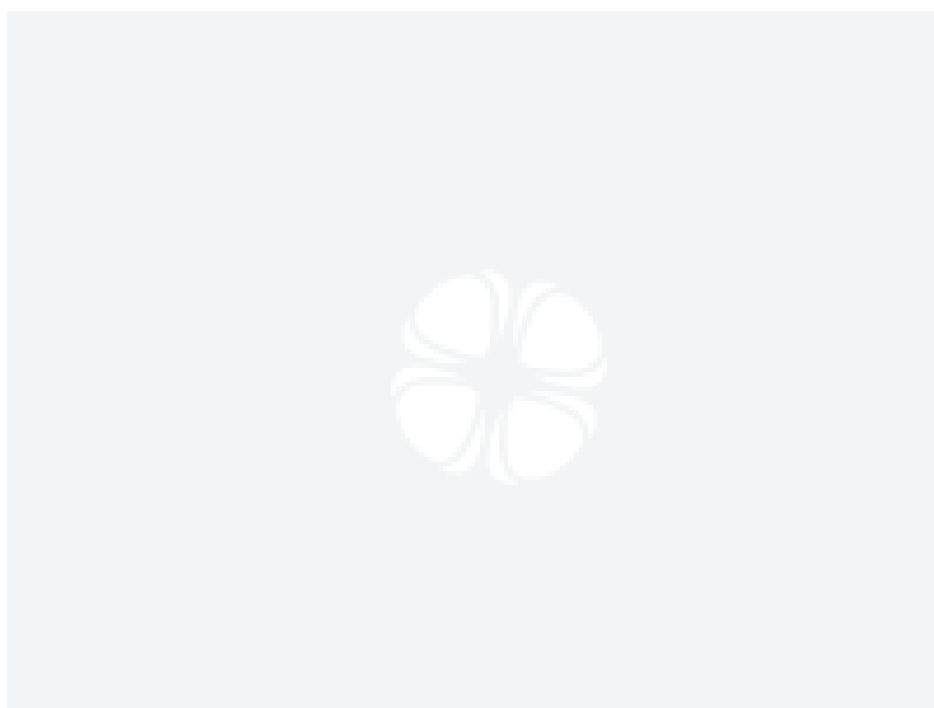   孢子囊堆照片 **- 3**分

Node Id: **6a4d9b0329ea9cbf4ea884f1**
  **Sporophyll photo – 3 points**
  孢子葉照片 **- 3分**
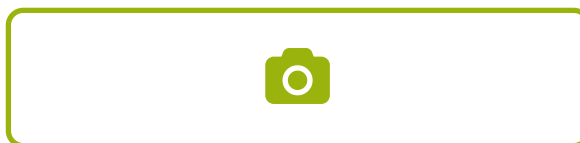
Node Id: **379dca56a5de63afd25ecd40**
  **Microphyll photo – 3 points**
  小葉照片 **- 3分**

Node Id: ac3175622c88a8769d588c79
**Sporangium photo – 3 points**
孢子囊照片 **- 3**分

Node Id: d6a9dc9827bc8c3c00205865
**Sepal photo – 3 points**
萼片照片 **- 3**分

Node Id: **f898ed61d4577f6c39dc2cb3**
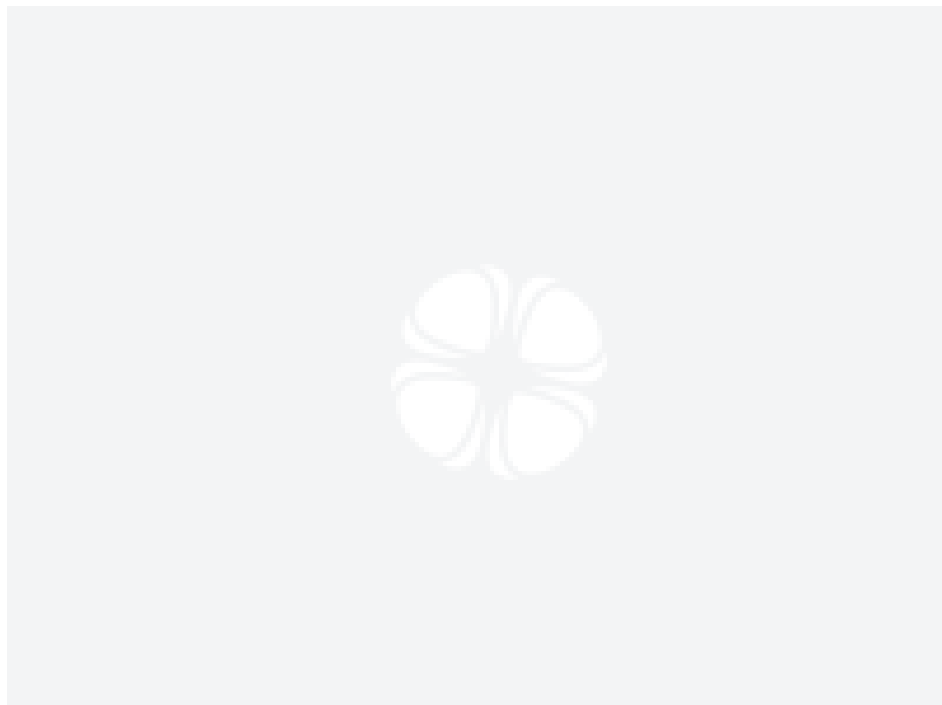**Seed photo – 3 points**
種子照片 **- 3**分

Node Id: **25837501b0f20b2b0684e77a**
**Pollen grains photo – 3 points**

花粉粒照片 - **3**分

[📷]

[→]

Node Id: **9ac52e1fe05303feb968e84e**

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# 3. MORPHOLOGICAL VARIATION AND CHARACTER MATRIX CODING (29 POINTS)
## 第3題 形態變異及特徵矩陣編碼(29分)

As a first step in the character analysis, we want you to describe the morphological variation across the following eight species in a way that will allow for mapping character evolution on a phylogenetic tree:

分析特徵時，第一步是先要描述下列這8個物種的形態變異，以利將特徵演化對應標示在親緣關係樹上。

1  *Allium ursinum*寬葉蒜
2  *Equisetum arvense* 木賊
3  *Lycopodium annotinum* 杉葉蔓石松
4  *Pinus sylvestris* 歐洲赤松
5  *Pisum sativum* 豌豆
6  *Polypodium vulgare* 歐亞多足蕨
7  *Polytrichum commune* 土馬騌
8  *Selaginella kraussiana* 小翠卷柏

In Table 3.1. below you will find 9 morphological characters of key importance for the evolution of the Land Plants listed. Each character is broken down into two states. Notice that the assignment of character states implies an evolutionary direction, where '0' indicates the least derived (older) condition and '1' the derived (newer) condition:

在下列的表3.1中，共有9個對陸生植物演化的重要關鍵性形態特徵，每個特徵可分為兩種狀態 (states)。特徵的狀態代表其演化方向，'0' 代表祖徵狀態；'1'代表裔徵狀態。

Table 3.1. Definition of character states (0 or 1) for 9 characters.
表3.1 9種不同特徵的特徵狀態(0 or 1)定義

| | State 0 狀態0 | State 1 狀態1 |
|---|---|---|
| Character 1 特徵1 | Dominated by gametophyte phase 配子體佔優勢 | Dominated by sporophyte phase 孢子體佔優勢 |
| Character 2 特徵2 | Stem without roots 莖沒有根 | Stem with roots 莖有根 |
| Character 3 特徵3 | Stem without vascular tissue 莖沒有維管束組織 | Stem with vascular tissue 莖有維管束組織 |
| Character 4 特徵4 | Female gametophyte released from sporophyte 雌配子體從孢子體釋出 | Female gametophyte retained on sporophyte 雌配子體留在孢子體上 |
| Character 5 特徵5 | One sporangium per sporophyte 每個孢子體只有一個孢子囊 | More than one sporangium per sporophyte 每個孢子體有一個以上的孢子囊 |
| Character 6 特徵6 | Sporophyll with either one sporangium or sporophyll absent. 孢子葉具有一個孢子囊，或沒有孢子葉 | Sporophyll with more than one sporangium 孢子葉具有一個以上孢子囊 |
| Character 7 特徵7 | Homosporous, i.e. with only one kind of spore 同型孢子(一種型態的孢子) | Heterosporous, i.e. with megaspores and microspores 異型孢子(具大孢子及小孢子) |
| Character 8 特徵8 | Male gametes motile 雄配子可運動 | Male gametes not motile 雄配子不能運動 |
| Character 9 特徵9 | Without double fertilization 沒有雙重受精 | With double fertilization 有雙重受精 |

🏳 | Q. 3　　Character states for the eight study species (max 29 points)
8個物種的特徵狀態(最多29分)

Node Id: 4d13e727a058e4cca5eca547
  ○ **The next step in the character analysis is describing the morphological variation in a table called a character matrix.**
  **The character matrix below is constructed to describe the variation of the 9 above-mentioned key characters across the eight species, that we focus on in this exercise.**
  特徵分析的下一步驟是描述特徵變異構成一個表格稱為特徵矩陣。

下面的特徵矩陣是在本實作的**8**個物種，對應上述**9**種關鍵特徵所構成。

**Code the matrix by filling out the empty cells. For any given combination of a species and a character assign either the state '0' or the state '1' to the cell. We have already coded** *Selaginella kraussiana* **and additional 5 cells for you in fig 3.1**

在矩陣空格中填入編碼。每個物種的每個特徵的狀態可設為 '**0**' 或 '**1**' 並填於空格中。在圖**3.1**中，*Selaginella kraussiana* 的特徵編碼及額外的**5**個空格已幫你填入編碼。

**By tapping in a cell, you choose a state (1 or 0). First tap gives you '1', second tap gives you '0', and third tap deletes the content of the cell. NB: Please, be patient - a short delay when shifting between states may occur!**

在每個空格中，你可選**1** 或 **0**按一次為'**1**'、按二次為'**0**'、按三次則刪去空格中的答案。提醒：可能會有小延遲，耐心等待，修改答案才會出現。

**0–29 correct cell values earn you no points, wrong or no value give 0 point**
**Every correct cell value > 29 correct cells earns you 1 point. Max. 29 points for 58 correct cell values.**

若只答對**0-29**格，沒有分。超過**29**格答對，則美答對**1**格得**1**分，答錯或空白則得**0**分。最高**29**分(**58**格答對)。

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| Allium ursinum 寬葉蒜 | | | | | | | | | |
| Equisetum arvense 木賊 | | | | | | | | | |
| Lycopodium annotinum 杉葉蔓石松 | | | | | | | | | |
| Pinus sylvestris 歐洲赤松 | | | | | | | | | |
| Pisum sativum 豌豆 | | | | | | | | | |
| Polypodium vulgare 歐亞多足蕨 | | | | | | | | | |
| Polytrichum commune 土馬騌 | | | | | | | | | |
| Selaginella kraussiana 小翠卷柏 | | | | | | | | | |

| | Character number: 特徵編號 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Allium ursinum | | | | | | 1 | | | |
| Equisetum arvense | | | | | | 1 | | | |
| Lycopodium annotinum | | | | | | | | | |
| Pinus sylvestris | | | | | | 1 | | 1 | |
| Pisum sativum | | | | | | 1 | | | |
| Polypodium vulgare | | | | | | | | | |
| Polytrichum commune | | | | | | | | | |
| Selaginella kraussiana | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |

*Figure 3.1:* Cell values provided to Question 4.
圖*3.1* 問題*4*的空格可填入的數值

# 4. MAPPING CHARACTER EVOLUTION ON A PHYLOGENETIC TREE (21 POINTS)
## 第4題　在親緣關係樹上的對應特徵的演化(21分)

A phylogenetic tree is a hypothesis about the ancestral relationships among a set of study organisms (Fig. 4.1).
親緣關係樹是有關所研究一批生物的祖裔關係的假說(圖4.1)。
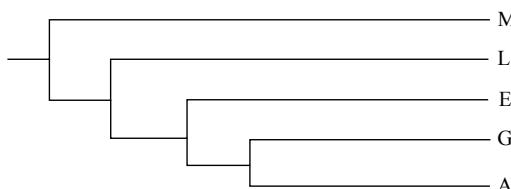


**Figure 4.1:** *A phylogenetic tree showing the hypothetical relationships among the five major lineages of land plants. G = Gymnosperms; L = Lycophytes; A = Angiosperms; M = Mosses; E = Ferns and their allies (Monilophytes).*
圖4.1: 此關係樹顯示陸生植物的5個主要支系的假設之親緣關係。G = 裸子植物; L =石松類; A =被子植物; M = 苔類; E =蕨類及其相近類群 *(Monilophytes)*

In this next step, we map character evolution on a given phylogenetic tree such as the one shown in Fig. 4.2. The tree represents a worldwide consensus between different hypotheses about the evolution of land plants.
在下一步驟，如圖4.2中所示，將特徵之演化對應在親緣關係樹上。此關係樹為現今世上針對陸生植物演化的幾種不同假說之共識版本。

We will use a character mapping procedure called deleted transformation (DELTRAN). Proceed according to the following protocol:
我們將使用一個特徵對應原則稱為deleted transformation (DELTRAN)，依下列流程操作。

1. Characters are only allowed to change forward from '0' to '1'.
   特徵狀態之改變只容許由0到1。

2. Minimize the number of times that a character changes on the tree (principle of parsimony)
   在關係樹上的特徵改變次數愈少愈好 (簡約原則)。

3. If it is impossible to restrict a change in a given character to just a single branch, then let the character change more than once (parallel evolution).
   若不可能限制某一特徵的狀態改變只發生在單一分枝上，那麼特徵改變次數就會超過一次(平行演化)。

4. Indicate on the tree on which branch a given character changes state. Notice that changes of characters evolving in parallel (= changing state several times) is indicated with two vertical bars (||), whereas a unique character state change ( = changing a single time) is indicated with a single vertical bar (|). Finally, indicate the number of the character that changes its state from 0 to 1 such as shown on the tree below.
   在關係樹的分枝上標示某一特徵的狀態改變，注意: 當特徵改變呈現平行演化 (亦即特徵狀態改變多次)，則用兩條垂直線(||)劃記在分枝上；若特徵狀態僅為單一改變 (亦即特徵狀態只有一次改變)，則用一條垂直線(|)劃記在分枝上。最後，當特徵狀態由0改變為1，則須標示特徵的編號，如下列的樹狀圖上所示。
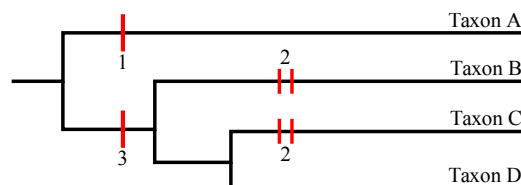
**Figure 4.2:** *A hypothetical phylogeny of four taxa A–D.*
圖4.2: 4個分類群A–D的親緣關係假說。

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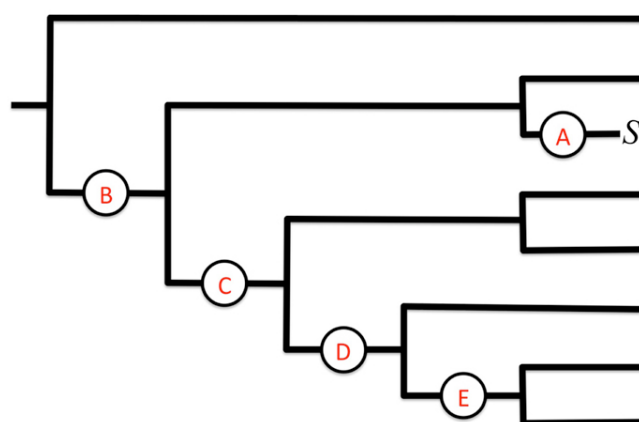
🏴 | Q. 4        Phylogenetical relationships of the eight study species (21 points)
                8個研究物種的親緣關係(21分)

Node Id: **6e4cbdd45d554a0e213b0567**
**Place the species at the correct branch tips.**
把物種放在適當的分枝末端



🏴 | Q. 5

Node Id: **dd3c122eda75a899ecbaa9ab**
**In the table below you find the branches A-E of the phylogeny above in the rows and the key characters 1-9 in the columns. By tapping on the cells you indicate on which branches the character state changes occur, according to the DELTRAN principle described above. One tap gives you a unique character change, two taps a parallel character change. A third tap will delete the content of the cell. Notice that the character state changes may be unevenly distributed over the phylogenetic tree and consequently some cells will have to be left empty.**
在下表中，可見關係樹的分枝**A-E**在最上一列，關鍵特徵**1-9**在欄中，根據上述**DELTRAN**原則，按下每一格則會顯示哪個分支上的特徵狀態發生改變。按一下為單一特徵狀態改變、按二下為平行特徵改變、按三下則刪去每格中的內容。注意特徵改變可以不平均分布在親緣關係樹上，因此某些格子將可能會是空白。

**0-15 correct cells give you 0 point.**
**1-15**格答對，得 **0**分。

**16-40 correct cells give you 8 points**
**16-40**格答對，得 **8**分。

**41–45 correct cells give you 16 points**
**41-45**格答對，得 **16**分。

|  | = 單一特徵狀態改變 | | = 平行特徵改變 |

|  | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| Branch A |  |  |  |  |  |  |  |  |  |
| Branch B |  |  |  |  |  |  |  |  |  |
| Branch C |  |  |  |  |  |  |  |  |  |
| Branch D |  |  |  |  |  |  |  |  |  |
| Branch E |  |  |  |  |  |  |  |  |  |

## 5. EVOLUTION OF KEY CHARACTERS IN LAND PLANTS (9 POINTS)
## 第5題 陸生植物的關鍵特徵之演化 (9分)

Based on reconstruction of character evolution similar to what you have just been through, botanists discuss the drivers of early land plant evolution. Two hypotheses are widely accepted:
根據特徵演化的重新建構 (如同你剛進行的過程)，植物學家探討早期陸生植物的演化方式，目前有兩種假說較被接受:

**Hypothesis H1**: Early evolution in land plants reflects an increasing independence of water for completion of reproduction
假說1: 陸生植物的早期演化可反映出有性生殖不需依賴水的現象有增加的趨勢。

**Hypothesis H2**: Evolution in land plants reflects an increasing ecophysiological ability to cope with dessication.
假說2: 陸生植物的演化可反映出適應乾燥的生態生理能力有增加的趨勢。

Notice that the hypotheses are not necessarily mutually exclusive
注意: 此兩個假說並不一定會相互排斥。

|▶ | Q. 6 | Choice of evolutionary hypotheses (max. 9 points)
選擇演化假說(最多9分)

Node Id: **8ece47fa23b1943f045981c4**
    **Based on part 4, indicate below for each character state change, whether this supports H1, H2, both or none.**
根據第**4**部分，在下列顯示每個特徵狀態改變，是否支持**H1, H2**, 兩個都有或都沒有。

    **Each correct answer in a cell earns you 1 point.**
每答對一格正確，則得**1**分。

| | Support 支持 | No support 不支持 |
|---|---|---|
| | ✓ = | — = |

|  | H1 | H2 |
|---|---|---|
| Change in character 1　特徵1的改變 | ☐ | ☐ |
| Change in character 2　特徵2的改變 | ☐ | ☐ |
| Change in character 3　特徵3的改變 | ☐ | ☐ |
| Change in character 4　特徵4的改變 | ☐ | ☐ |
| Change in character 5　特徵5的改變 | ☐ | ☐ |
| Change in character 6　特徵6的改變 | ☐ | ☐ |
| Change in character 7　特徵7的改變 | ☐ | ☐ |
| Change in character 8　特徵8的改變 | ☐ | ☐ |
| Change in character 9　特徵9的改變 | ☐ | ☐ |

END　本實作結束