



電子顯微鏡生態探索 Electron Microscope Eco Exploration

姓名 Name _____

組別 Group _____

日期 Date _____

學習目標 Learning goals

完成課程後，學生應能：After the course, students should be able to:

1. 理解光學顯微鏡和電子顯微鏡的運作原理 Understand the operation principle of light microscope and electron microscope;
2. 操作光學顯微鏡和掃描電子顯微鏡作生物觀察 Operate light microscope and scanning electron microscope for biological observation ;
3. 仔細觀察和準確記錄 Observe carefully and record precisely;
4. 用不同的方法去驗證已有的知識 Use different methods to verify existing knowledge;
5. 與他人合作進行考察和資料整理工作 Cooperate with others to conduct field investigation and data processing;
6. 製作簡單科學報告 Make simple scientific report;
7. 欣賞大自然之美和尊重生物 Appreciate the wonder of nature and respect living things.

程序 Schedule

09:00 - 09:45	簡介 Briefing
09:45 - 10:15	搜集樣本 Collecting samples
10:15 - 11:30	電子顯微鏡觀察 SEM observation
11:30 - 12:00	搜集樣本 Collecting samples
12:00 - 13:00	午膳 Lunch
13:00 - 14:30	電子顯微鏡觀察 SEM observation
14:30 - 15:30	數據分析 Data analysis
15:30 - 16:30	分組匯報 & 總結 Group presentation & summary

儀器和工具 Equipment and tools

1	寫字夾板 (x1) Clipboard	6	剪刀 (x1) scissors
2	平板電腦 (x1) Tablet computer	7	立體顯微鏡 (x1) Stereo microscope
3	圖鑑 (x1) Wildlife Pictorial Guide	8	培養皿 (x5) petri dishes
4	掃描電子顯微鏡 (x1) Scanning electron microscope	9	濺射鍍膜機 (x1) Sputter coater
5	鑷子 (x1) Forceps	10	導電雙面膠貼 (x1) Double-side conductive adhesive tape

衣著 Clothing

1. 不應穿著短褲。穿著長袖上衣和長褲能更有效防止蚊蟲叮咬，亦可減低被太陽曬傷的機會。
Shorts are not recommended. Long-sleeved shirt and trousers for better protection against mosquito and insect bites, as well as preventing sunburn.
2. 不應穿著拖鞋或涼鞋，而應穿著運動布鞋，以減低腳部受傷的機會。
A pair of plimsolls for preventing injuries. Slippers and sandals are not recommended.

安全 Safety

1. 避免踏足陡斜和濕滑的岩石表面。
Avoid stepping on steep and wet rock surfaces.
2. 切勿闖入植物生長茂密的地方，以免觸及蜂巢或被植物割傷。
To prevent being attacked by wasps from disturbed wasp nests or being injured by plant leaves and thorns, do not get into places with dense vegetation.

你知道吗？ Do You Know?

2021年中國科學院海洋研究所的科學家透過電子顯微鏡對比塑膠表面降解情況，首次發現能有效降解塑膠垃圾的海洋微生物。研究成果已成功申請國家發明專利，望未來可協助解決海洋垃圾問題。

In 2021, scientists from the Institute of Oceanography, Chinese Academy of Sciences, made a groundbreaking discovery by identifying marine microorganisms capable of effectively degrading plastic waste. They used electron microscopy to compare the degradation of plastic surfaces. The research findings have been successfully applied for a national invention patent, and it is hoped that they can contribute to solve the issue of marine plastic pollution in the future.



1. 收集花粉樣本 Pollen collection

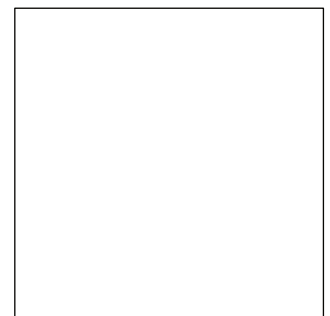
在可觀中心花園或附近地方收集兩種不同植物成熟的花，並記錄植物資料。

Collect 2 mature flowers from different plant species at Ho Koon Eco-garden and record the information of the plant.

	花粉所屬植物的學名 Scientific name of the pollen-bearing plant	俗名 Common name	科名 Family name
1			
2			

2. 處理花粉樣本 Pollen sample preparation

- 在載物台表面貼上雙面導電膠貼。
 - 利用立體顯微鏡協助摘下成熟雄蕊，然後將雄蕊在導電膠貼表面塗擦。
 - 將雄蕊置於載物台上，並於工作紙上以圖畫或文字標示樣本位置。
 - 將載物台連同處理好的樣本置於濺射渡膜儀，鍍上一層十分薄的金屬。
- Adhere specific double-sided adhesive tape to the stage surface.
 - Pick the anther from the flower under stereomicroscope and rub the anther on the adhesive surface.
 - Adhere the anther onto the metal stage and label the position of the samples with text or drawing.
 - Place the stage with samples into the sputter coater to coat a thin layer of metal.



樣本標示圖
Sample Labelling Diagram

3. 使用電子顯微鏡觀察花粉 Observation of pollen under SEM

將樣本置入掃描電子顯微鏡，進行仔細觀察和攝取圖像。

Put the sample into the SEM. Observe the sample carefully and capture images.

4. 解剖花朵 Flower dissection

- 將萼片、花瓣及雄蕊從花朵摘下。
 - 用刀片將雌蕊縱切，嘗試在立體顯微鏡下觀察胚珠。
 - 辨認花朵的各個結構，包括萼片、花瓣、花藥、花絲、柱頭、花柱、子房、胚珠，並將結構放在已標示的工作紙上。
 - 完成解剖後拍照記錄。
- Take off the sepals, petals and stamens from the flower.
 - Use a blade to cut the pistil longitudinally and try to observe the ovule under stereomicroscope.
 - Identify all structures of the flower, including sepals, petals, anthers, filaments, stigma, style, ovary, and ovule. Arrange the structure on the worksheet with label.
 - After completing dissection, take photos for record.

5. 收集昆蟲樣本 Insect collection

在可觀中心花園或附近地方收集兩種不同的昆蟲（建議身長不多於1厘米），並記錄其資料。

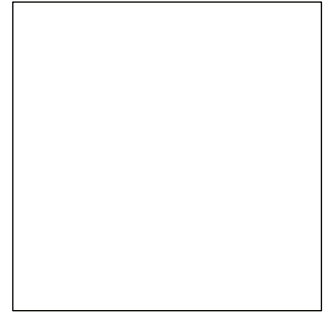
Collect 2 different insects (recommended body length with less than 1cm) at Ho Koon Eco-garden and record the information of the insects.

	昆蟲俗名 Name of the insect	觀察結構 Structure observed
1		
2		



6. 處理昆蟲樣本 Insect sample preparation

- 將昆蟲冷凍最少20分鐘，減慢其活動能力。
 - 在載物台表面貼上雙面導電膠貼。
 - 將昆蟲仔細地置於載物台上，並於工作紙上以圖畫或文字標示樣本位置。
 - 將載物台連同處理好的樣本置於濺射渡膜儀，鍍上一層十分薄的金屬。
- Freeze the insect specimens for as least 20 minutes to reduce their mobility.
 - Adhere specific double-sided adhesive tape to the stage surface.
 - Adhere the insect specimens onto the metal stage and label the position of the samples with text or drawing.
 - Place the stage with samples into the sputter coater to coat a thin layer of metal.



樣本標示圖

Sample Labelling Diagram

7. 使用電子顯微鏡觀察昆蟲 Observation of insect under SEM

將樣本置入掃描電子顯微鏡，進行仔細觀察和攝取圖像。特別留意觸角、複眼和足部附節的微結構。

Put the sample into the SEM. Observe the sample carefully and capture images. Pay special attention to the micro-structure of antennae, compound eyes and tarsi.

8. 顯微圖像分析 Microscopic images analysis

完成五個顯微圖像分析項目。

Complete the five tasks of microscopic images analysis.

項目 Task 1: 計算葉片氣孔密度 Calculate the density of stomata on the leaf (no. of stomata/cm²)

氣孔密度 Density of stomata : _____ no. of stomata/cm²)

項目 Task 2: 利用動物眼睛圖像配對生物 Match the animals with their eye images

圖 Picture A	圖 Picture B	圖 Picture C	圖 Picture D
動物名稱 Name of animal:	動物名稱 Name of animal:	動物名稱 Name of animal:	動物名稱 Name of animal:
_____	_____	_____	_____

項目 Task 3: 利用動物口器圖像配對生物 Match the animals with the mouthpart images.

圖 Picture A	圖 Picture B	圖 Picture C	圖 Picture D
動物名稱 Name of animal:	動物名稱 Name of animal:	動物名稱 Name of animal:	動物名稱 Name of animal:
_____	_____	_____	_____



項目 Task 4: 計算花粉體積 Calculate the volume of pollen.

勝紅薊 Goatweed 花粉體積 Volume of the pollen: _____cm ³	大紅花 Chinese Hibiscus 花粉體積 Volume of the pollen: _____cm ³
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項目 Task 5: 在以下位置繪畫顯微照片的低倍標註圖

Draw a labelled low-power diagram of photomicrograph on the space provided.

9. 分析和討論 Analysis and discussion

1. 比對不同植物的花粉之間的分別，並說明花粉特徵與該植物繁殖方式之間的關係。
Compare and contrast the pollens of different plant species and explain how are the pollen's characteristics related to its mode of reproduction.
2. 選擇三幅昆蟲電子顯微鏡圖像，簡單描述圖中的各項微結構，並指出各微結構的功能。
Select three insect images captured by the scanning electron microscope. Briefly describe the micro-structures shown and indicate the function of each micro-structure.