

**18<sup>th</sup> INTERNATIONAL BIOLOGY OLYMPIAD**  
**JULY 15 - 22, 2007**



**PRACTICAL EXAMINATION 2**

**PLANT ANATOMY, MORPHOLOGY AND PHYSIOLOGY**

**EXAM BOOKLET 1**

**TASK A.** Identification of plant structures and organs 16 marks

**Time allowed: 20 minutes**

**WRITE YOUR 4-DIGIT STUDENT NUMBER IN THE BOX  
BELOW**

<b>STUDENT CODE</b>	
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**PLANT MORPHOLOGY**

**TASK A.** Identification of plant structures and organs from images shown in a PowerPoint presentation (16 marks)

In this task, you are required to answer the following questions, each of which relates to a slide that you will be shown. **Each slide will be shown twice.**

In the first showing, each slide will be displayed for 45 seconds, then the second slide will be shown for 45 seconds and so on until all 16 slides have been once. The second showing is to give you the opportunity to review your answers. In this showing, each slide will be displayed for 15 seconds.

**FOR EACH QUESTION,  
WRITE THE LETTER OF YOUR ANSWER IN THE SPACE PROVIDED**

1. What mutualistic relationship between roots of land plants and specific soil fungi is displayed in this slide?

- a. mycorrhizae
- b. mycelium
- c. lichens
- d. root hairs

**ANSWER: \_\_\_ a \_\_\_**

2. This leaf's venation is commonly found in which group of plants?

- a. hornworts
- b. dicotyledons
- c. ferns
- d. monocotyledons
- e. gymnosperms

**ANSWER: \_\_\_ b \_\_\_**

3. The aerenchyma stem tissue shown here is characteristic of its adaptation as a:

- a) mesophyte
- b) xerophyte
- c) halophyte
- d) hydrophyte

**ANSWER: \_\_\_ d \_\_\_**

4. What type of plant do these leaf cross-sections represent?

- a) a monocot
- b) a lycopod
- c) a eudicot
- d) a tree
- e) a fern

**ANSWER:**   a  

5. In this picture of a fern sorus, what is the ploidy level of the structure indicated by the arrow?

- a) triploid
- b) diploid
- c) haploid

**ANSWER:**   c  

6. In this longitudinal section of a dicot angiosperm stem, name the structure indicated by 'X'.

- a) shoot apical meristem
- b) axillary bud
- c) lateral inflorescence
- d) lateral root
- e) leaf primordium

**ANSWER:**   b  

7. The arrow in this slide is indicating:

- a) sclerenchyma fibre
- b) sieve tube element
- c) vessel element
- d) chlorenchyma
- e) sclereid

**ANSWER:**   c  

8. What is the function(s) of the structure indicated by the arrow?

- a) to prevent an insect proboscis reaching phloem sap
- b) to provide mechanical support to the xylem tissue
- c) to initiate the formation of interfascicular vascular cambium
- d) all of the above
- e) none of the above

**ANSWER:**   a

9. The name of the meristem responsible for generating the tissues labelled 'X' is:

- a) vascular cambium
- b) shoot apical meristem
- c) root apical meristem
- d) cork cambium
- e) lenticel

**ANSWER: \_\_\_\_\_ d \_\_\_\_\_**

10. The presence of the following illustrated cells gives *Pyrus communis* L. (pears) their gritty texture:

- a) chlorenchyma
- b) guard cell
- c) tracheary element
- d) collenchyma
- e) sclereid

**ANSWER: \_\_\_\_\_ e \_\_\_\_\_**

11. This type of phyllotaxy is best described as:

- a) whorled
- b) distichous
- c) opposite
- d) alternate

**ANSWER: \_\_\_\_\_ a \_\_\_\_\_**

12. The hormone auxin, produced at the terminal meristem, inhibits lateral shoot growth which results in the illustrated phenomenon, known as:

- a) conical shape
- b) deciduousness
- c) apical dominance
- d) axillary dominance

**ANSWER: \_\_\_\_\_ c \_\_\_\_\_**

13. These tendrils and spines represent evolutionary adaptations of what structures?

- a) leaves
- b) branches
- c) axillary shoots
- d) adventitious roots
- e) trichomes

**ANSWER: \_\_\_\_\_ a \_\_\_\_\_**

14. Which plant cell type shown has the potential to give rise to all of the other cells in the section?

- a) parenchyma
- b) companion
- c) collenchyma
- d) sclereid
- e) tracheary element

ANSWER:     a    

15. In embryo development, the structure indicated by the arrow is known as the:

- a) filament
- b) endosperm
- c) heart-shaped embryo
- d) suspensor
- e) basal cell

ANSWER:     d    

16. What plant group does this slide represent?

- a) angiosperms
- b) bryophytes
- c) tracheophytes
- d) pteridophytes

ANSWER:     b    

**- THE END -**

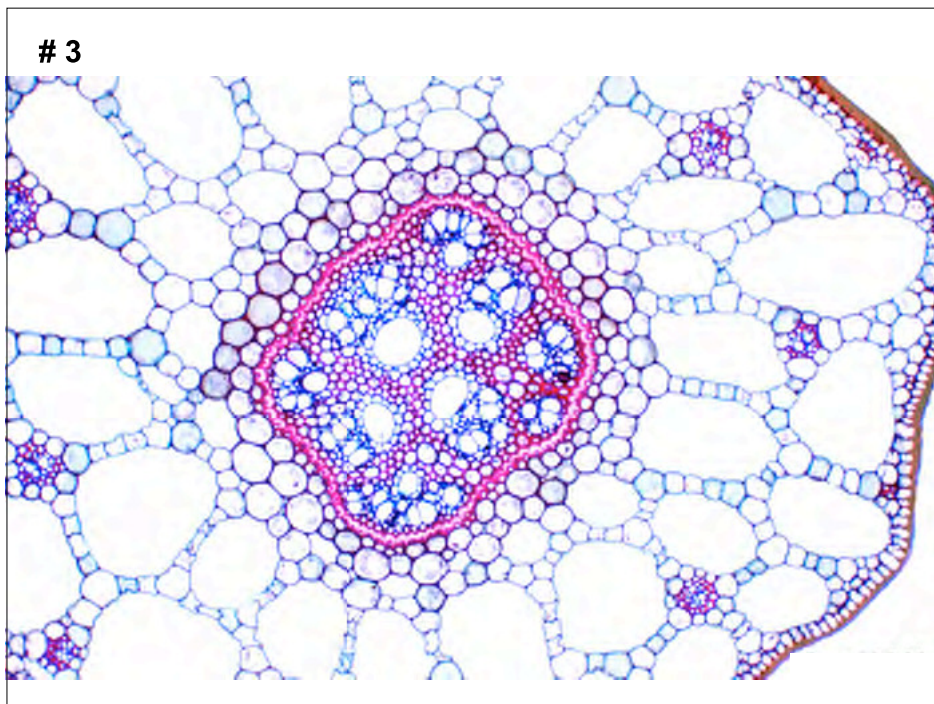
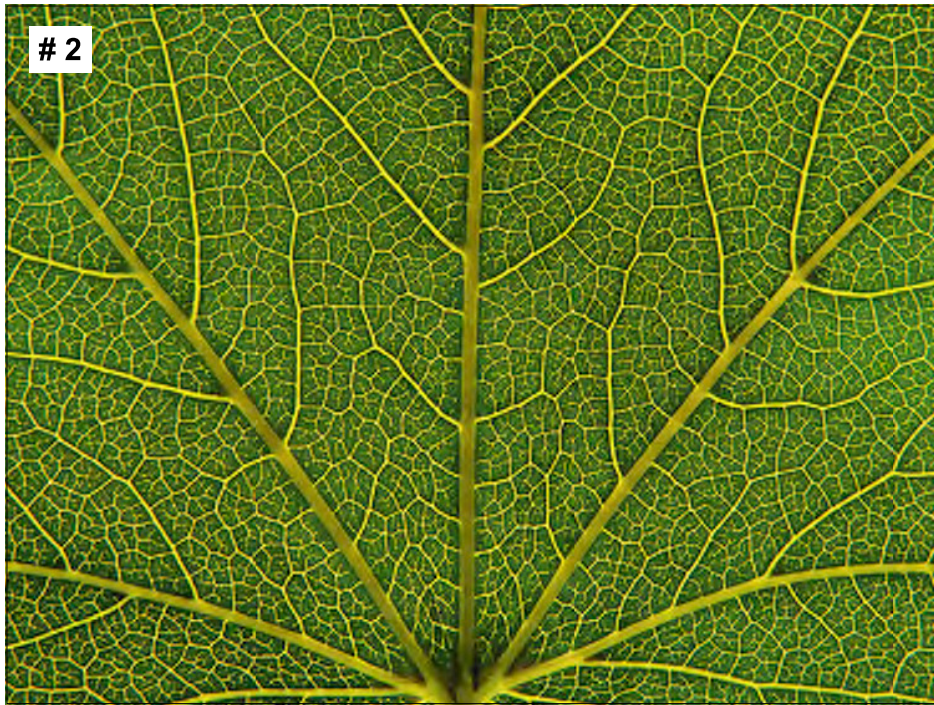
**HAVE YOU WRITTEN YOUR STUDENT CODE ON THE FIRST PAGE OF THIS EXAM BOOKLET AND ON THE TOP OF EVERY OTHER PAGE?**

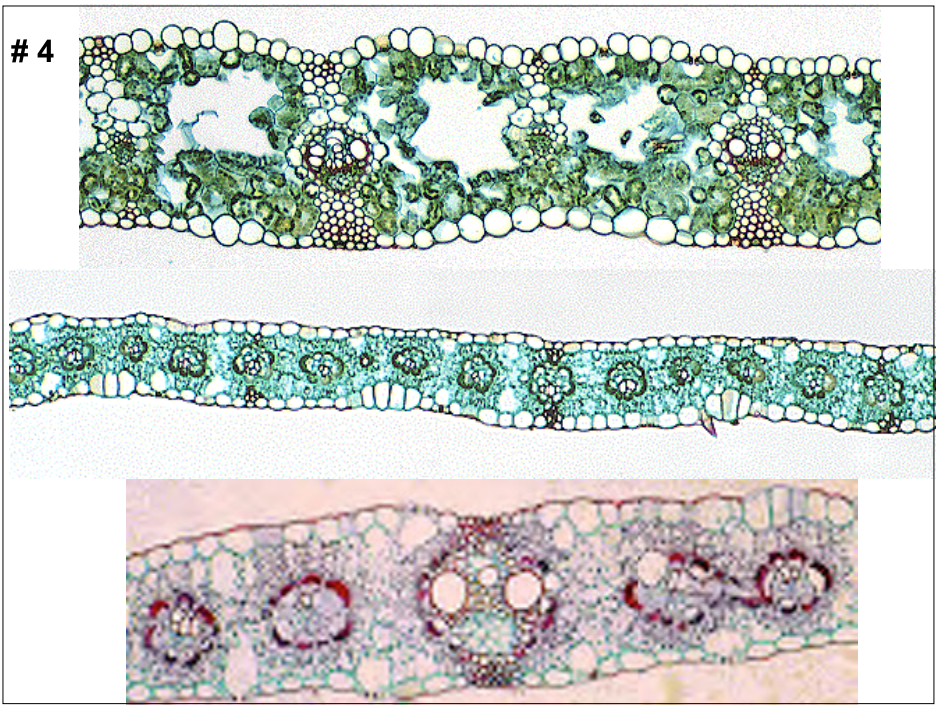
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# 1





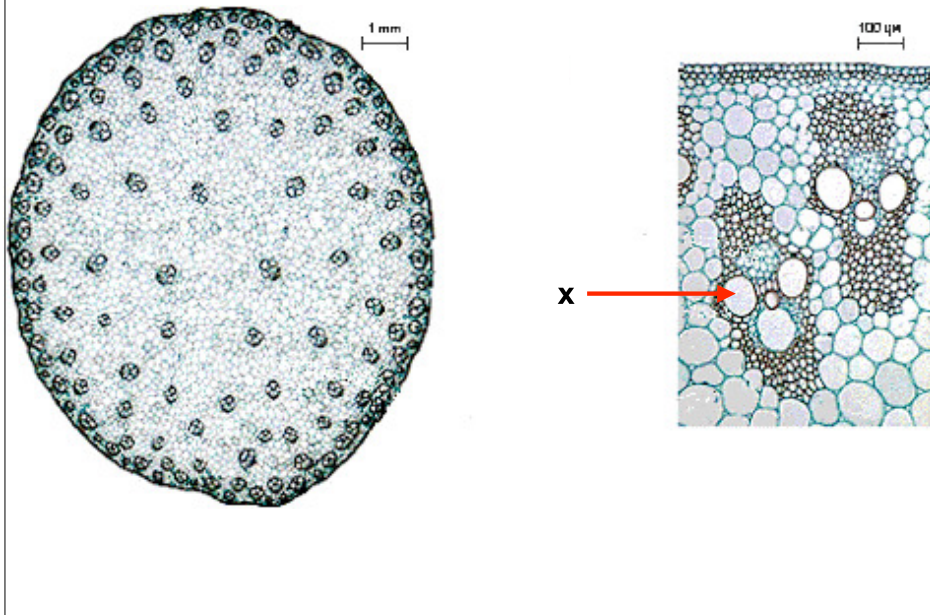


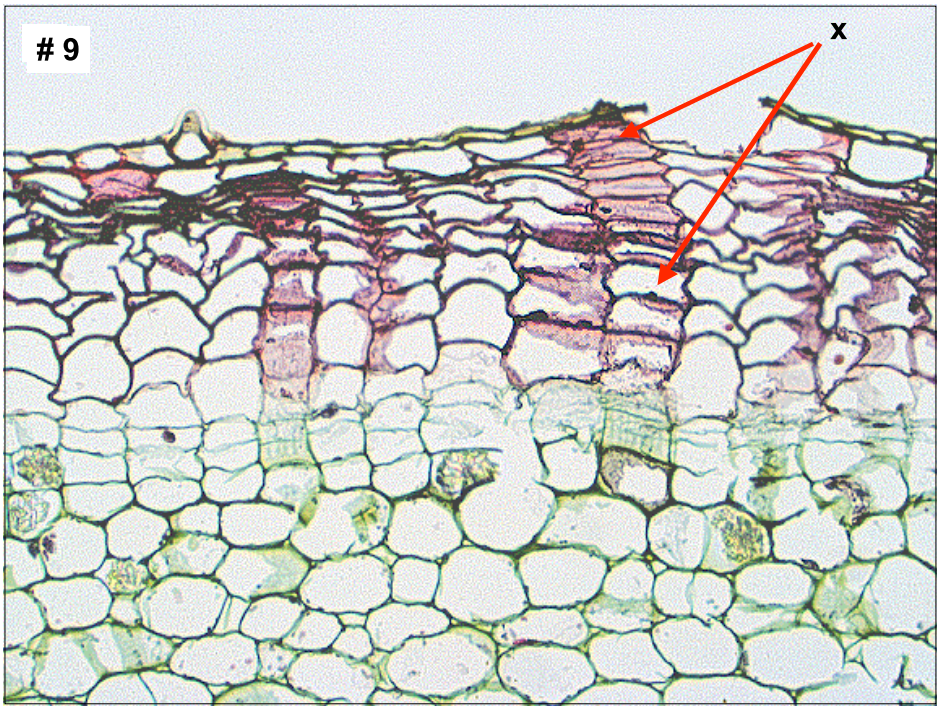
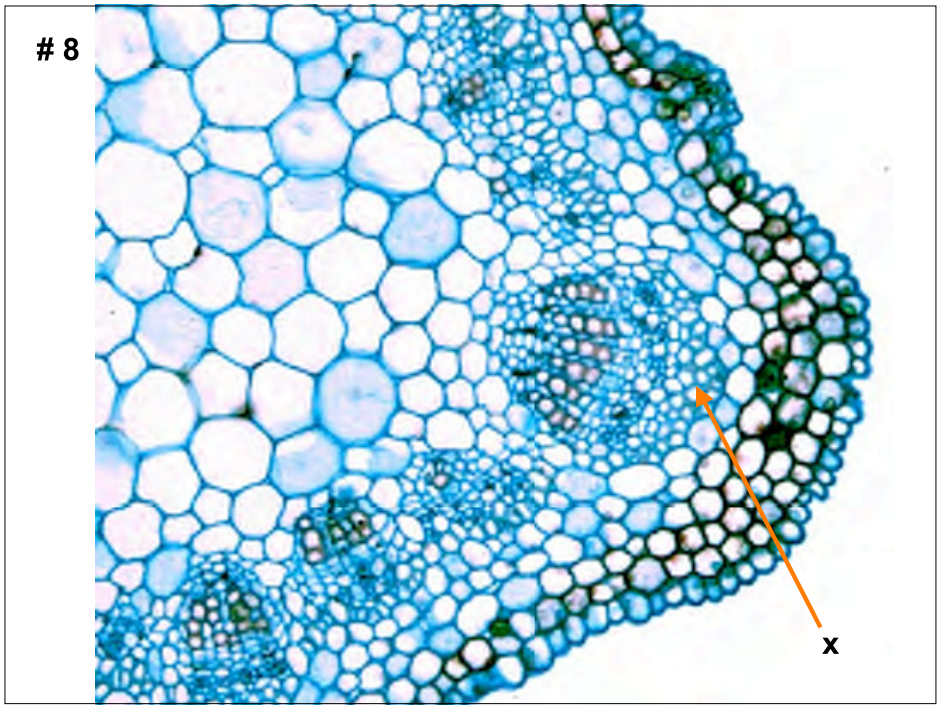


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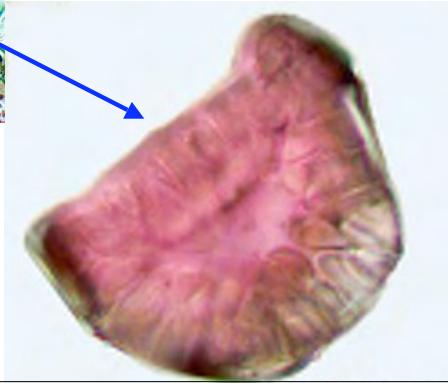
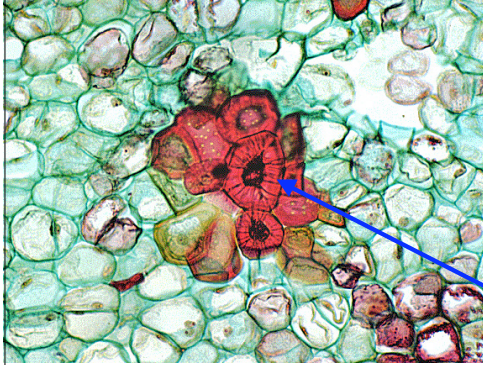


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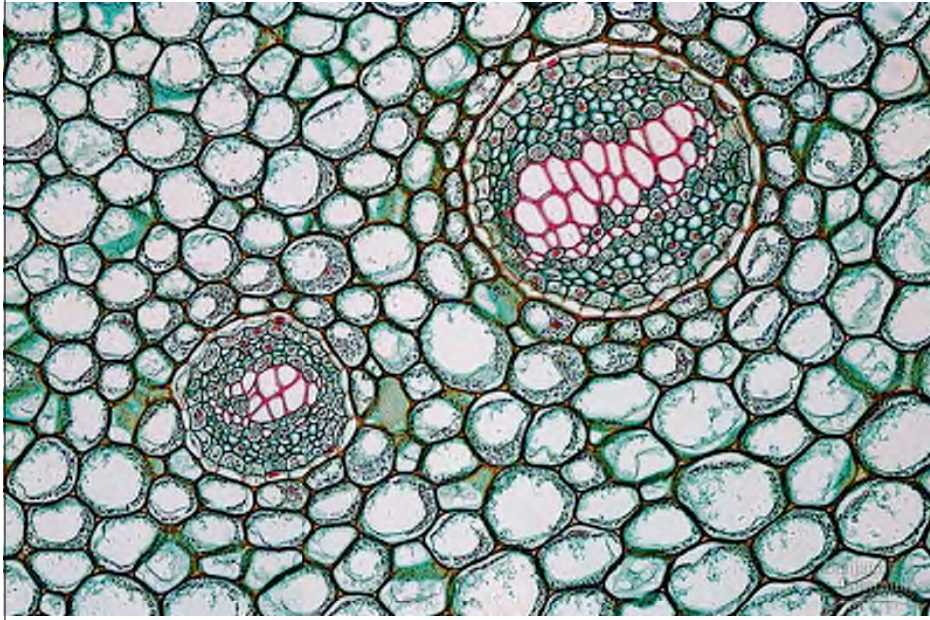
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# 16



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**PRACTICAL EXAMINATION 2**

**PLANT ANATOMY, MORPHOLOGY AND PHYSIOLOGY**

**EXAM BOOKLET 2**

- |  |          |
|--|----------|
| <b>Task B.</b> Identification of flowering plants  | 23 marks |
| <b>Task C.</b> Dissection of a seed and a flower   | 25 marks |
| <b>Task D.</b> Plant evolution                     | 5 points |
| <b>Task E.</b> Graphing and interpretation of data | 8 marks  |

**Time allowed: 70 minutes**

(Total time allowed for Practical Examination 2 = 90 minutes)

**WRITE YOUR 4-DIGIT STUDENT CODE IN THE BOX BELOW  
AND ON THE TOP OF EACH PAGE OF THIS EXAM BOOKLET**

<b>STUDENT CODE</b>	
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## GENERAL INSTRUCTIONS

### IMPORTANT

- **Before starting the exam, the invigilator will show you a red card and a green card to test for red-green color blindness. If you are unable to see the difference between the two cards, raise your hand, and you will be provided with assistance immediately.**
- Read the exam paper carefully before commencing the exam.
- It is recommended that you allocate your time according to the mark value of the Task.
- Write your answers in the exam booklet.
- **Do not forget to hand in your graph prepared in Task E with your exam booklet.**

**BE SURE THAT YOU HAVE WRITTEN YOUR 4-DIGIT STUDENT CODE ON THE FIRST PAGE OF EACH EXAM BOOKLET**

### IMPORTANT INFORMATION FOR TASKS B AND C

- **Handle the plant samples with care.** Some samples will be used in more than one TASK.
- When you have completed **Part 7 of Task B**, please indicate so by placing your plastic bag cover back on top of the microscope and a lab assistant will grade the quality of your section.
- Make sure that you have completed **Parts 5, 6 and 7 of TASK B** before commencing **TASK C**.
- It is important that you cover your dissection board with paper towel to indicate you have completed **Task C1** (Seed Dissection) and **Task C3** (Flower Dissection). In each case, a lab assistant will ask you to sign your specimen board, photograph your dissection and then remove the dissection for marking.



## PLANT ANATOMY and MORPHOLOGY

### Materials

- 10 petri dishes containing plant samples 1 to 10
- 1 foam core specimen board labeled **SEED DISSECTION** with four coloured pins (1 black, 1 white, 1 yellow, 1 blue)
- 1 foam core specimen board labeled **FLOWER DISSECTION** with seven coloured pins (1 orange, 1 white, 1 yellow, 1 blue, 1 pink, 1 green, 1 black)
- 1 single-edge razor blade
- 1 dissecting kit
- 6 glass microscope slides
- 1 box of cover slips
- 1 drop bottle containing toluidine blue staining solution
- 1 drop bottle containing distilled water
- 3 tissues
- 1 light microscope
- 1 pair disposable gloves
- Paper towel

**NOTE:** Before beginning this task, be sure that you have all the materials listed above. If you do not, notify a lab assistant immediately by raising your hand.

### **TASK B. Identification and classification of flowering plant samples based on their anatomy and morphology. (23 marks)**

#### **Procedure:**

1. Using the razor blade, cut a thin cross section of each of the samples 1 to 4.
2. Transfer each section to a microscope slide and place 1 drop of toluidine blue staining solution and 1 drop of water on the section.
3. Put a cover slip on the section (try to avoid air bubbles when placing the cover slip) and remove excess stain by placing the corner of a piece of tissue paper against one edge of the cover slip.
4. Starting first with the 4X objective and then using either the 10X or the 40X objective, examine each slide under the microscope and observe the structure of the tissue.

5. Based on your observation of each slide prepared for samples 1 to 4, identify the tissue/organ sectioned. For each sample, enter the appropriate letter from the column labeled **KEY** in the table below. (8 marks)

Sample	Tissue/Organ
1	B
2	C
3	B
4	C

**KEY**

A = leaf

B = stem

C = root

D = petiole

6. Examine the sections you prepared for Samples 1 to 4, and the plant parts of Samples 5 to 10. Identify whether each sample is from a monocot plant or from a dicot plant and indicate your answer by writing an "X" in the appropriate column of the following table. (10 marks)

Plant Sample	Monocot	Dicot
1	X	
2		X
3		X
4	X	
5		X
6	X	
7	X	
8	X	
9	X	
10		X

7. **Once you have completed Part 6, place the slide with your best section on the microscope, focus the microscope and place your plastic bag cover back on the microscope indicating to the lab assistant that you are finished.** A lab assistant will examine the slide and grade your sectioning technique (5 marks).

**TASK C. SEED AND FLOWER ANATOMY AND MORPHOLOGY (25 marks)****IMPORTANT. Make sure that you have completed TASK B before starting TASK C.****TASK C1. SEED ANATOMY (8 marks)****Procedure**

1. Write your student number on the specimen board labeled **SEED DISSECTION**.
2. Using **Sample 5** cut the seed longitudinally with the razor blade and dissect the seed into its component parts.
3. Use the pins provided to pin the correct seed part on the specimen board
  - **black** pin for the **testa** (seed coat)
  - **white** pin for the **cotyledon**
  - **yellow** pin for the **plumule** (foliage leaves)
  - **blue** pin for the **radicle**.
4. **After finishing this task, cover the board with a paper towel indicating to the lab assistant that you are finished.** The lab assistant and yourself will sign the label on the specimen board, and the lab assistant will photograph your dissection. Your dissection will then be removed for grading.

**TASK C2. FLOWER MORPHOLOGY (2 marks)****Procedure**

1. Examine the flower in **Sample 6**. Write an “X” against the correct answer for the following questions:

(a) The sepals alone make up the

- |                |         |
|----------------|---------|
| i) corolla     | _____   |
| ii) calyx      | ___X___ |
| iii) perianth  | _____   |
| iv) hypanthium | _____   |

(b) The petals alone make up the whorl known as

i) corolla \_\_\_\_\_X\_\_\_\_\_

ii) calyx \_\_\_\_\_

iii) perianth \_\_\_\_\_

iv) hypanthium \_\_\_\_\_

**TASK C3. FLOWER ANATOMY (15 marks)**

**IMPORTANT. You must have completed TASK B before commencing this dissection.**

**Procedure**

1. Write your student number on the specimen board labeled **FLOWER DISSECTION**.
2. Dissect the flower (**Sample 6**) into its component parts.
3. Use the pins provided to pin the correct flower part on the specimen board
  - **orange** pin for a sepal (2 mark)
  - **white pin** for a petal (2 marks)
  - **yellow** pin for an anther (2 marks)
  - **pink** pin for the filament (2 marks)
  - **green** pin for the style (2 marks)
  - **blue** pin the stigma (2 marks)
  - **black** pin for the ovary (2 marks)
4. Use an “**X**” to indicate the correct classification of the placentation within the ovule of this flower (1 mark).

i) marginal \_\_\_\_\_

ii) axile \_\_\_\_\_X\_\_\_\_\_

iii) parietal \_\_\_\_\_

iv) free-central \_\_\_\_\_

5. **After finishing this task, cover the board with a paper towel to indicate to the lab assistant that you are finished.** A lab assistant will photograph your dissection. Both the lab assistant and yourself will sign the label on the board. Your dissection will then be taken by the lab assistant for grading.

## PLANT EVOLUTION

### TASK D. Identification of the Time of Evolution of Higher Plants (5 marks)

#### Materials

- Plant samples in dishes labeled H to M. **DO NOT OPEN THE PETRI DISHES.**
- Photograph of the evolutionary time scale (Figure 1)

**NOTE:** Before beginning this task, be sure that you have all the materials listed above. If you do not, notify a lab assistant immediately by raising your hand.

#### Procedure

These plant samples possess characteristics representative of their ancestral lineages. Read the descriptions in Box A and identify the description that is most correct for each plant sample.

1. Using the codes (1 to 6) representing the different time periods in the evolutionary time scale shown in Figure 1), indicate the geologic time period that best corresponds to each description.
2. Enter the two codes (one related to the description and one related to the evolutionary time period) for each sample in Box B.

**NOTE:** **Not all descriptions in Box A will be used and no letter should be used more than once.** The answer for Sample M is provided.

**BOX A****Plant Sample Lineage Characteristics**

- a. This spore-bearing plant group has persisted relatively unchanged for hundreds of millions of years. In this time period, it was likely an important dietary element of herbivore dinosaurs.
- b. The first macrofossil evidence of the evolution of grasses appears in the fossil record at the time of the diversification of mammals.
- c. In this time period, the indehiscent integumented megasporangium (ovules/seeds) originated. It is represented in the samples by modern plants producing naked seeds on a scale.
- d. This group of spore-bearing plants included members with tree-like stature (Sample M) and were common in coal-producing swamp floras (**answers provided**).
- e. Coniferous seed plants, as represented by the sample, were driven to extinction by the diversification of the superior characteristics of the angiosperms, in this time period.
- f. The dichotomous branching and sporangia of this plant were characteristics of the first terrestrial tracheophytes, which left some of the earliest land plant macrofossils at this time in history.
- g. The evolution of flowering plants, as represented by this angiosperm, first appears in the fossil record in this time period.

<b>BOX B</b>		
<b>Enter the correct codes for each sample</b>		
<b>Sample</b>	<b>Description</b>	<b>Time Period</b>
H .....	g	5
I .....	f	1
J .....	a	4
K .....	b	6
L .....	c	2
M .....	d	3



## PLANT PHYSIOLOGY

### TASK E. Interpretation of photosynthetic data from plants grown at different light levels (8 marks)

#### Materials

- 2 sheets of graph paper, each with the axes labeled differently

**NOTE:** Before beginning this task, be sure that you have all the materials listed above. If you do not, notify a lab assistant immediately by raising your hand.

#### Introduction

Single leaves from two different plants, one grown in full sun, the other in shade, were removed and placed in separate, clear boxes. The leaves were exposed to increasing light levels and the rate of O<sub>2</sub> release was measured.

The data obtained from this experiment are presented in the following table:

Light Level ( $\mu\text{mol photons m}^{-2} \text{ s}^{-1}$ )	Rate of O <sub>2</sub> production ( $\mu\text{mol O}_2 \text{ m}^{-2} \text{ s}^{-1}$ )	
	Leaf A	Leaf B
0	-20	-2
10	-10	-0.5
25	-5	1.5
50	-1	3
100	5	6
250	15	10
500	28	12
600	30	11

#### Procedure

1. Select the sheet of graph paper that has the X-axis and the Y-axis labeled correctly for the set of data above. (1 mark)
2. Write your name and your student number on the label on the sheet of graph paper you have chosen.
3. Mark the scale of the units on each axis.
4. Plot the data presented in the table for each leaf to compare the photosynthetic rates (O<sub>2</sub> production) of the leaves with respect to light. Clearly identify which line represents **Leaf A** and which line represents **Leaf B**. (2 marks)

5. Examine the graphs you have drawn and determine which leaf (**Leaf A** or **Leaf B**) demonstrates the characteristics of a shade-adapted leaf and which demonstrates the characteristics of a sun-adapted leaf. Indicate your answer in the table below by writing an "X" in the correct cell. (1 mark)

	Leaf A	Leaf B
Shade-adapted		X
Sun-adapted	X	

6. Use the data plots on your graph to answer the following questions:

- (a) Is the light compensation point of **Leaf A** higher than the light compensation point of **Leaf B**? Circle the correct answer. (0.5 mark)

YES                  NO

- (b) Can the light compensation point be defined as the light level at which the photosynthetic response reaches saturation? (0.5 mark)

YES                  NO

- (c) Which of the answers below most correctly identifies the light compensation point of **Leaf A**? Circle the letter of that answer. (1 mark)

i) between -10 and -5  $\mu\text{mol O}_2 \text{ m}^{-2} \text{ s}^{-1}$

ii) between 10 and 20  $\mu\text{mol O}_2 \text{ m}^{-2} \text{ s}^{-1}$

iii) between 25 and 50  $\mu\text{mol photons m}^{-2} \text{ s}^{-1}$

iv) **between 50 and 75  $\mu\text{mol photons m}^{-2} \text{ s}^{-1}$**

v) between 500 and 600  $\mu\text{mol photons m}^{-2} \text{ s}^{-1}$

(d) Which of the answers below best describes the maximum rate of photosynthesis of the sun leaf? Circle the letter of that answer. (1 mark)

i)  $12 \mu\text{mol O}_2 \text{ m}^{-2} \text{ s}^{-1}$

ii)  $15 \mu\text{mol O}_2 \text{ m}^{-2} \text{ s}^{-1}$

**iii)  $30 \mu\text{mol O}_2 \text{ m}^{-2} \text{ s}^{-1}$**

iv) between 250 and 600  $\mu\text{mol photons m}^{-2} \text{ s}^{-1}$

v) greater than 600  $\mu\text{mol photons m}^{-2} \text{ s}^{-1}$

(e) This graph gives information about the photosynthetic response to light. Can it also be used to estimate the response of respiration rate with regards to light? Circle the correct answer. (1 mark)

YES

NO

- THE END -

HAVE YOU WRITTEN YOUR STUDENT CODE ON THE FIRST PAGE OF  
THIS EXAM BOOKLET AND ON THE TOP OF EACH PAGE?

REMEMBER TO HAND IN YOUR GRAPH PAPER WITH THIS EXAM  
BOOKLET.

FIGURE 1. DIAGRAM FOR TASK D.

