

18th 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 AND ON THE TOP OF EACH PAGE OF THIS BOOKLET**

STUDENT CODE	
---------------------	--

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 viewed 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 (lower case) 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:** _____

2. This leaf's venation is commonly found in which group of plants?
- a. hornworts
 - b. dicotyledons
 - c. ferns
 - d. monocotyledons
 - e. gymnosperms
- ANSWER:** _____

3. Aerenchyma stem tissue shown here is characteristic of its adaptation as a:
- a) mesophyte
 - b) xerophyte
 - c) halophyte
 - d) hydrophyte
- ANSWER:** _____

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: _____

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: _____

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: _____

7. The arrow in this slide is indicating:

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

ANSWER: _____

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: _____

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: _____

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

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

ANSWER: _____

11. This type of phyllotaxy is best described as:

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

ANSWER: _____

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: _____

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

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

ANSWER: _____

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

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

ANSWER: _____

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: _____

16. What plant group does this slide represent?

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

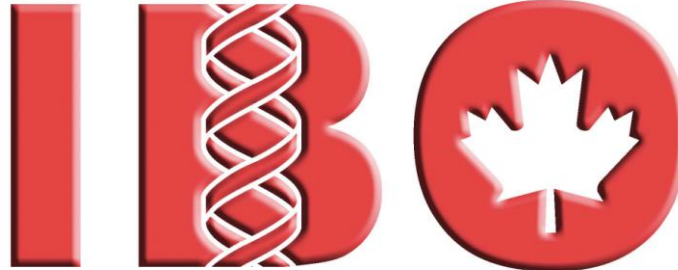
ANSWER: _____

- THE END -

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

18th INTERNATIONAL BIOLOGY OLYMPIAD
JULY 15 - 22, 2007

International Biology Olympiad



Saskatoon Canada 2007

PRACTICAL EXAMINATION 2

PLANT ANATOMY, MORPHOLOGY AND PHYSIOLOGY

EXAM BOOKLET 2

Task B. Identification of flowering plants	21 marks
Task C. Dissection of a seed and a flower	23 marks
Task D. Plant evolution	5 points
Task E. 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**

STUDENT CODE	
---------------------	--

GENERAL INSTRUCTIONS

IMPORTANT

- **Before starting the exam, the invigilator will show you a red card and a green card to test for red-green colour 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

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 by placing your plastic bag cover over 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 with a paper towel to indicate that 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. (21 marks)

Procedure:

1. Using the razor blade, cut a thin cross section of each of the samples labeled 1 to 4.
2. Transfer each section to a separate 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	
2	
3	
4	

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		
2		
3		
4		
5		
6		
7		
8		
9		
10		

7. **Once you have completed Part 6, place the slide with your best section from the samples 1 – 4 on the microscope and focus the microscope. Please indicate that you have finished this task by placing your plastic bag cover over the microscope and a lab assistant will grade the quality of your section. (3 marks).**

After grading, this slide will be labeled with your student code and your signature, and be taken for storage.

TASK C. SEED AND FLOWER ANATOMY AND MORPHOLOGY (16 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 have finished.** Both the lab assistant and you yourself **must** 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)**IMPORTANT. You must have completed TASK A before commencing this task.****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 _____
 - iii) perianth _____
 - iv) hypanthium _____

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

i) corolla _____

ii) calyx _____

iii) perianth _____

iv) hypanthium _____

TASK C3. FLOWER ANATOMY (15 marks)

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 (1 mark)
- **white** pin for a petal (1 mark)
- **yellow** pin for an anther (1 mark)
- **pink** pin for the filament (1 mark)
- **green** pin for the style (1 mark)
- **blue** pin the stigma (1 mark)
- **black** pin for the ovary (1 mark)

4. Use an “**X**” to indicate the correct classification of the placentation within the ovule of this flower.

i) marginal _____

ii) axile _____

iii) parietal _____

iv) free-central _____

5. **Please indicate that you have finished the task by covering the board with a paper towel.** A lab assistant will photograph your dissection. Both the lab assistant and you yourself will sign the label on the board and record the time. 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: If you **DO NOT** have all the materials listed above, 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 by using the relevant lower case letter, 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 this sample by modern plants producing naked seeds on scales.
- d. This group of spore-bearing plants included members with tree-like stature (Sample M) and was 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.

BOX B		
Enter the correct codes for each sample		
Sample	Description	Time Period
H	_____	_____
I	_____	_____
J	_____	_____
K	_____	_____
L	_____	_____
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 O₂ 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 ₂ 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 (O₂ 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 box below. (1 mark)

	Leaf A	Leaf B
Shade-adapted		
Sun-adapted		

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? Circle the correct answer. (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.**