

**MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD
UNIVERSITY OF MALTA, MSIDA**

**MATRICULATION CERTIFICATE EXAMINATION
ADVANCED LEVEL
SEPTEMBER 2012**

SUBJECT:	BIOLOGY
PAPER NUMBER:	I
DATE:	4th September 2012
TIME:	9.00 a.m. to 12.00 noon

Directions to Candidates

- *Write your index number in the space at the top left-hand corner of this page.*
- *Answer ALL questions. Write all your answers in the spaces provided in this booklet.*
- *The mark allocation is indicated at the end of each question. Marks allocated to parts of questions are also indicated.*
- *You are reminded of the necessity for good English and orderly presentation in your answers.*
- *In calculations you are advised to show all the steps in your working, giving your answer at each stage.*
- *The use of electronic calculators is permitted.*

For examiners' use only:

Question	1	2	3	4	5	6	7	8	9	Total
Score										
Maximum	15	12	15	14	6	5	15	8	10	100

Answer ALL questions.

1. Prokaryotes, mitochondria and chloroplasts have many features in common.

1.1. Name TWO features which are common to both prokaryotes and chloroplasts.

[two marks]

1.2. Which evolutionary theory can be deduced from the similarities between prokaryotes and chloroplasts?

[one mark]

1.3. The table below lists some features found in organelles. Indicate whether the named features are found in chloroplasts and/or mitochondria by marking **present** or **absent** in the respective spaces.

Features	Present / Absent in	
	chloroplasts	mitochondria
Crista		
Granum		
Stroma		
Matrix		
Glycogen granule		
Thylakoid membrane		

[six marks]

1.4. In the presence of oxygen, glucose is broken down via a number of metabolic pathways that occur in different regions of the eukaryotic cell. State where and how many ATP molecules are yielded during each of the following metabolic pathways.

Metabolic pathways	Location within the cell	Number of ATP molecules yielded
Glycolysis		
Pyruvate oxidation		
Krebs' cycle		
Electron-transport chain		

[four marks]

- 1.5. What are the following chemicals converted to, as they are utilized by the electron-transport chain?

Chemical into the electron transport chain	Converted to
NADH + H ⁺	
FADH ₂	
ADP + P _i	
Oxygen	

[two marks]

[Total: fifteen marks]

2. This question is about transport through the plasma membrane.

- 2.1. Complete the table below by inserting an appropriate word or words in the empty boxes.

Component	Subunits	Chemical bond between subunits	Role in transport
Phospholipids		ester bonds	
Proteins	amino acids		
Carbohydrate side chains			receptors

[three marks]

- 2.2. Complete the table below using a **YES** if you agree with the statement, and a **NO** if you disagree.

Transport Method	Uses energy	Uses proteins	Is specific
Diffusion			
Osmosis			
Facilitated diffusion			
Active transport			

[four marks]

2.3. Proteins found in plasma membranes are produced through the processes involved in protein synthesis, which occurs within the cell.

Briefly explain the role of the following processes in protein synthesis:

(i) *transcription*;

[two marks]

(ii) *post-transcriptional processing*.

[two marks]

2.4. Where within the eukaryotic cell does transcription occur?

[one mark]
[Total: twelve marks]

3. This question is about the nervous system.

3.1. Explain what is meant by each of the following terms:

(i) *Action potential*;

[two marks]

(ii) *Neurotransmitter*;

[two marks]

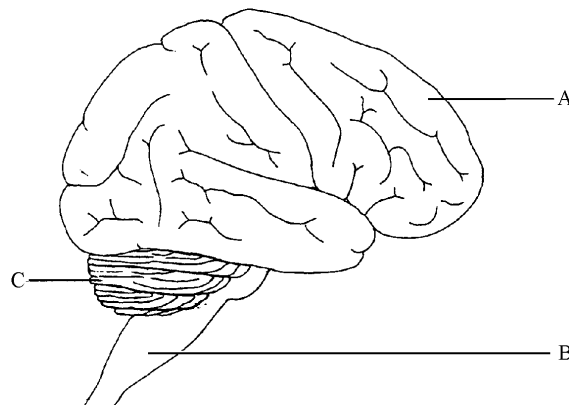
(iii) *Myelination*.

[two marks]

3.2. Briefly explain the role of ions in the propagation of an action potential along a neuron.

[four marks]

3.3. The diagram below shows a human brain as seen from the right hand side.



(i) Name the parts labelled A, B and C.

A: _____ B: _____

C: _____

[three marks]

(ii) Give **TWO** functions of the part labelled B.

[two marks]

[Total: fifteen marks]

4. This question is about the immune system.

4.1. Distinguish between the terms:

(i) *first line of defence* and *second line of defence*;

[three marks]

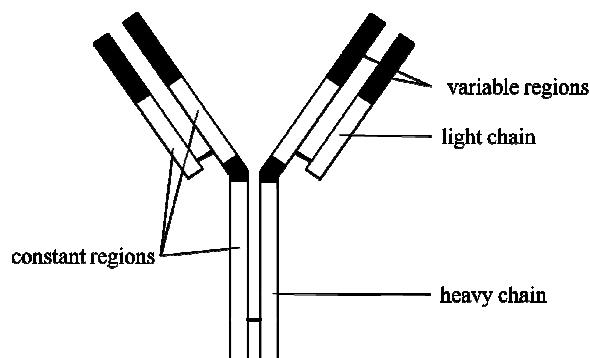
(ii) *macrophage* and *B cell*;

[three marks]

(iii) *vaccination* and *antibody injection*.

[three marks]

4.2. The diagram below shows an antibody molecule.



(i) Name the simplest monomers that form the heavy and light chains of antibodies.

[one mark]

(ii) Name the chemical bonds that join the light chain to the heavy chain.

_____ [one mark]

(iii) Briefly explain how the specificity of an antibody depends on its variable regions.

[three marks]
[Total: fourteen marks]

5. This question is about plant fertilisation.

5.1. The tip of the growing pollen tube releases digestive enzymes into the style. Suggest the role of these digestive enzymes in the growth of the pollen tube.

[two marks]

5.2. In angiosperms, once the pollen tube reaches the micropyle, double fertilisation occurs.

Which female nuclei are fertilized during double fertilisation?

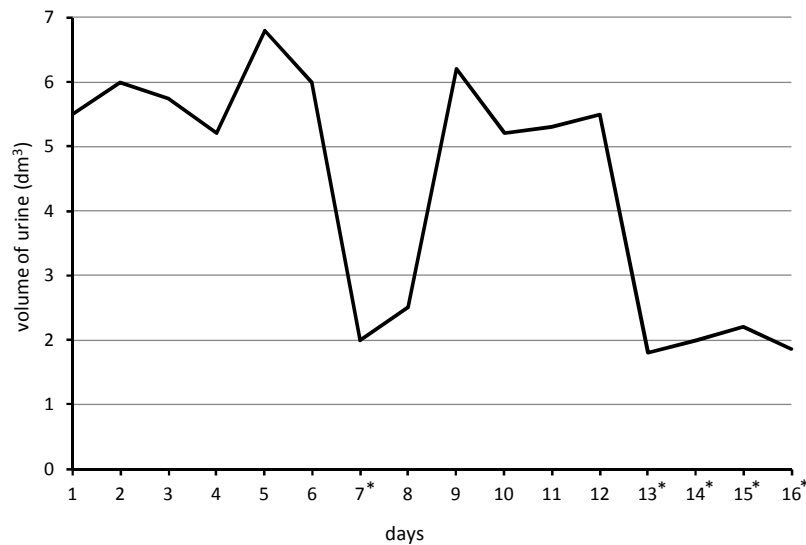
[two marks]

5.3. What do the fertilised nuclei give rise to?

[two marks]
[Total: six marks]

DO NOT WRITE ABOVE THIS LINE

6. Diabetes insipidus is a condition in which large volumes of dilute urine is produced. The volume of urine produced each day by a patient with this condition was recorded and is shown in the graph below. During the same period of time, on the days marked with * the patient received an injection of pituitary extract in the morning.



- 6.1. Describe the effect of the injection of pituitary extract on the volume of urine produced.

[one mark]

- 6.2. Name a possible substance responsible for this effect.

[one mark]

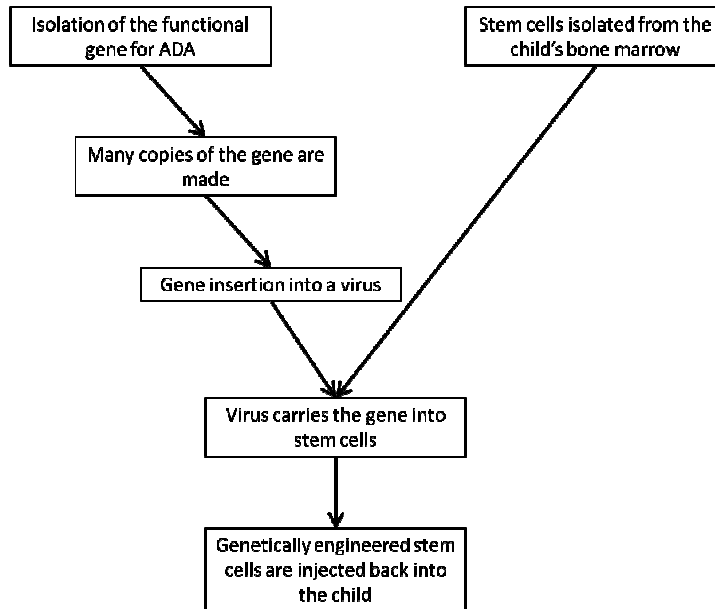
- 6.3. Describe how the substance named in Question 6.2. brings about a change in the volume of urine produced.

[three marks]

[Total: five marks]

7. This question is about the principle, techniques and applications of gene technology.

Children with severe combined immunodeficiency disorder (SCID) cannot produce many types of white blood cells. This is because they do not have the functional gene to make the enzyme ADA. Some children with SCID have been treated using stem cells. Stem cells can divide and develop into any type of blood cell including white blood cells. A simplified flow diagram of the treatment used is described below.



7.1. What is meant by the term *gene*?

_____ [one mark]

7.2. From where can a functional gene for ADA be isolated?

_____ [one mark]

7.3. In relation to the processes named in the flow diagram above, describe the role of:

(i) *restriction endonucleases*;

 _____ [two marks]

(ii) *ligase*.

 _____ [two marks]

7.4. Briefly name and explain ONE modification (other than the insertion of the gene of interest) usually done to the virus used in this treatment above?

[two marks]

7.5. Using the information given, suggest and explain why bone marrow stem cells were used in this treatment.

[three marks]

7.6. The PCR can be used to obtain many copies of a gene. During a PCR, two different primers are added to the DNA.

(i) What does PCR stand for?

[one mark]

(ii) Which enzyme is responsible for making copies of the gene during PCR?

[one mark]

(iii) Starting with a single DNA molecule, the PCR was allowed to go through four complete cycles. How many molecules of DNA would be produced?

[two marks]

[Total: fifteen marks]

8. This question is about the lac operon. The lac operon, found in *E. coli*, is responsible for the production of three constitutive enzymes which are inducible in the presence of lactose.

8.1. What is meant by the terms:

(i) *constitutive enzymes*;

[two marks]

(ii) *inducible enzymes.*

[two marks]

8.2. Briefly explain the role played by the repressor protein in the function of the lac operon.

[four marks]

[Total: eight marks]

9. This question is about ecology.
Briefly explain the meaning of the following ecological terms:

9.1. *Net primary production;*

[two marks]

9.2. *Pyramid of numbers;*

[two marks]

9.3. *Community;*

[two marks]

9.4. *Realized niche;*

[two marks]

9.5. *Ecological succession.*

[two marks]

[Total: ten marks]

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD
UNIVERSITY OF MALTA, MSIDA

MATRICULATION CERTIFICATE EXAMINATION
ADVANCED LEVEL
SEPTEMBER 2012

SUBJECT:	BIOLOGY
PAPER NUMBER:	II
DATE:	5th September 2012
TIME:	9.00 a.m. to 12.00 noon

Directions to Candidates

- *Answer the question in Section A, any TWO questions from Section B and ONE question from Section C. Write all your answers in the separate booklet provided.*
 - *If more than two questions from Section B are attempted, only the first two answers shall be taken into consideration.*
 - *If more than one question from Section C is attempted, only the first answer shall be taken into consideration.*
 - *The mark allocation is indicated at the end of each question. Marks allocated to parts of questions are also indicated.*
 - *You are reminded of the necessity for good English and orderly presentation in your answers.*
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-

SECTION A (this section is **obligatory**)

1. Read carefully the following extract. Then using the information provided and your knowledge of biology, answer the questions that follow. The numerals in the left-hand margin are line numbers.

Plastic ingredient makes fish court other species.

Bisphenol A (BPA) is a common chemical used to make plastics. This chemical has been found to cause certain species of fish to indiscriminately court members of other closely related species, a behaviour that could result in interbreeding and ends up merging two species into one. Typically, interspecific differences in phenotypic traits serve as mate
5 recognition signals and therefore maintain reproductive isolation between closely related sympatric species.

BPA affects animals' development and behaviour because it mimics the hormone oestrogen. Such "synthetic hormones" can affect the males of many species, sometimes impairing their ability to produce offspring. In addition, a recent study by Dr. Ward of the
10 University of Minnesota, has shown that BPA can have another negative effect. Dr. Ward exposed two captive fish species, *Cyprinella venusta* and *C. lutrensis*, to BPA for 14 days. The courtship behaviour of the fish exposed to BPA was then compared to the courtship behaviour of unexposed fish, with the latter serving as a control experiment.

Dr. Ward's study showed that the fish exposed to BPA were more likely to approach fish
15 of the other species and court them. Although this study did not include genetic tests to confirm that interspecific courtship behaviour led to interbreeding, Ward said that the courtship behaviour is a "good proxy for mate choice in fish", and thus could lead to interbreeding given that in rare occasions even without BPA, these two species are known to hybridise.

20 Moreover, *C. lutrensis* is an alien species which is often introduced to new areas by fishermen who use them as bait. Thus the introduction of the alien species together with the increased chances of interbreeding due to BPA could be a big threat to the biodiversity in the area.

The concentrations of BPA that the fish were exposed to were orders of magnitude higher
25 than those experienced by humans in everyday life. Nevertheless, some scientists think that even very low concentrations of BPA may harm humans, so recently certain countries have banned this chemical from baby food containers.

Adapted from *Evolutionary Applications* July 2012

- 1.1. Briefly explain the terms:
(i) *interspecific differences* (line 4);
(ii) *sympatric species* (line 6).
[four marks]
- 1.2. Name one human activity that might increase the exposure of fish to BPA.
[one mark]
- 1.3. Suggest a phenotypic trait that can help species to mate only with other members of their own kind.
[two marks]
- 1.4. What are the long-term implications of exposure to BPA on fish?
[two marks]
- 1.5. Why can BPA be described as effectively breaking down a pre-zygotic isolating mechanism?
[three marks]
- 1.6. Propose how one would carry out the control experiment mentioned in *line 13*.
[three marks]
- 1.7. Briefly explain the importance of carrying out a control experiment in the above named study?
[two marks]
- 1.8. What conclusions would be expected in a genetic test (*line 15*) where interbreeding occurs?
[two marks]
- 1.9. What is an alien species (*line 20*)?
[one mark]
- 1.10. Why is interbreeding described as ‘a big threat to the biodiversity’ (*line 22*)?
[three marks]
- 1.11. Suggest why BPA has been banned from being used in food containers for babies?
[two marks]

[Total: twenty five marks]

SECTION B

(Answer any **TWO** questions from this section; your answers should take the form of essays. Each question carries twenty five marks).

2. Discuss the structure of the human alimentary canal in relation to digestion and absorption of food.
3. Discuss the role of proteins in human locomotion.
4. Give an account of the various terrestrial habitat types found in the Maltese islands, including an example of a typical local plant for each named habitat.
5. Write a general account on the movement of solutes in plants.

[Total: fifty marks]

SECTION C

(Answer **ONE** question from this section).

6. Distinguish between the following terms, including an example of an organism for each term:

- 6.1. *coelomate* and *acoelomate*;
- 6.2. *heterospory* and *homospory*;
- 6.3. *sexual reproduction* and *asexual reproduction*;
- 6.4. *internal fertilization* and *external fertilization*;
- 6.5. *bilateral symmetry* and *radial symmetry*.

[five marks each]

7. Use your knowledge of biology to explain the following statements:

- 7.1. the acrosome reaction ensures the formation of diploid offspring;
- 7.2. lactation is important for passive immunity;
- 7.3. entomophilous and anemophilous flowers have different specializations;
- 7.4. echinoderms exhibit secondary radial symmetry;
- 7.5. the bottleneck effect plays a major role in shaping a population.

[five marks each]

[Total: twenty five marks]

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD
UNIVERSITY OF MALTA, MSIDAMATRICULATION CERTIFICATE EXAMINATION
ADVANCED LEVEL
SEPTEMBER 2012

SUBJECT:	BIOLOGY
PAPER NUMBER:	III
DATE:	6th September 2012
TIME:	9.00 a.m. to 10.30 a.m.

Directions to Candidates

- *Write your index number in the space at the top left-hand corner of this page.*
 - *Answer ALL questions. Write all your answers in the spaces provided in this booklet.*
 - *The mark allocation is indicated at the end of each question. Marks allocated to parts of questions are also indicated.*
 - *You are reminded of the necessity for good English and orderly presentation in your answers.*
 - *In calculations you are advised to show all the steps in your working, giving your answer at each stage. Unless otherwise specified, you are advised to list results to one decimal place.*
 - *The use of electronic calculators is permitted.*
-

For examiners' use only:

Question	1	2	3	4	Total
Score					
Maximum	18	8	8	16	50

DO NOT WRITE ABOVE THIS LINE

1. This question is about photosynthesis.

1.1. Carbon dioxide is one of the factors that affects photosynthesis. Briefly outline a procedure that a scientist could utilise to monitor the effect of carbon dioxide concentration on the rate of photosynthesis.

[seven marks]

1.2. How would you expect the rate of photosynthesis to change when the concentration of carbon dioxide changes?

[three marks]

DO NOT WRITE ABOVE THIS LINE

To carryout photosynthesis, green plants utilise photosynthetic pigments such as chlorophylls and carotenoids. The graph below (Figure 1) shows the absorption spectrum of *chlorophyll a*, *chlorophyll b* and *carotene* respectively.

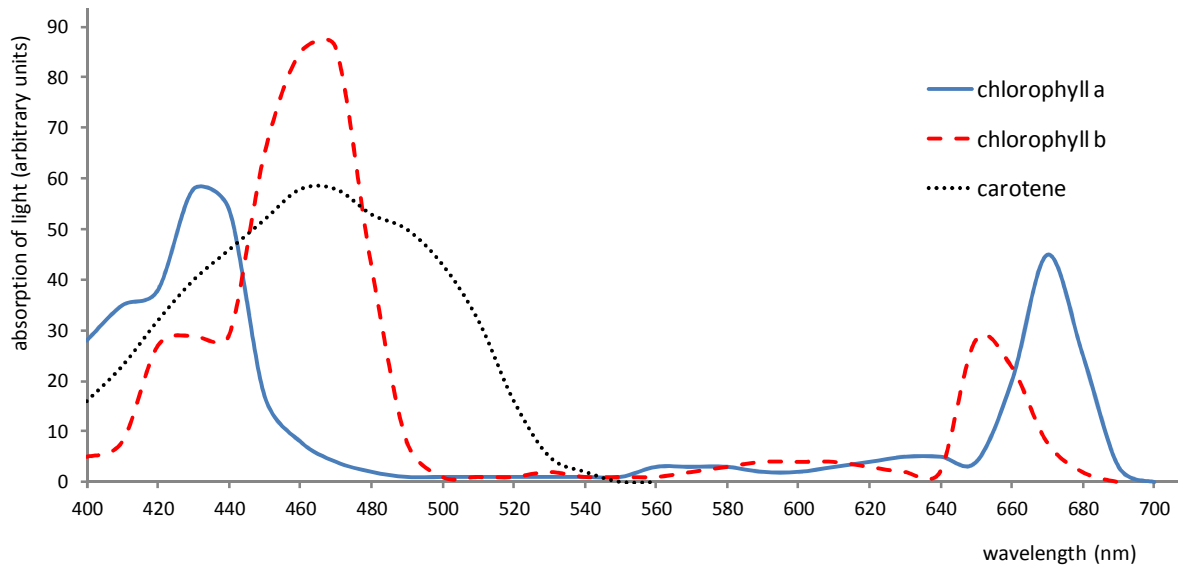


Figure 1

1.3. What is meant by the term *absorption spectrum*?

[one mark]

1.4. Give a brief explanation on the biological significance of chlorophyll by making reference to the absorption spectrum graph above.

[four marks]

- 1.5. Carotene is considered as an accessory pigment. Explain the role of carotene as accessory pigment using information obtained from the absorption spectrum graph in Figure 1.

[two marks]

- 1.6. Name a simple experimental technique that can be used to identify the different photosynthetic pigments found in green plants?

[one mark]

[Total: eighteen marks]

2. The photographs below (Figures 2, 3, 4 and 5) show four animals. In each case indicate the Phylum and Class, and give one visible diagnostic feature for each.



Figure 2

Phylum:

Class:

Diagnostic feature:



Figure 3

Phylum:
Class:
Diagnostic feature:



Figure 4

Phylum:
Class:
Diagnostic feature:



Figure 5

Phylum:
Class:
Diagnostic feature:

[Total: eight marks]

DO NOT WRITE ABOVE THIS LINE

3. A genealogist has built the pedigree chart below (Figure 6) when studying Huntington's disease and its inheritance through three generations. This disease is known to be inherited through an autosomal dominant allele (H), that affects males and females equally. The pedigree diagram below shows individuals affected by Huntington's disease as shaded symbols, while unaffected individuals are shown as unshaded symbols. Males are represented as squares and females as circles.

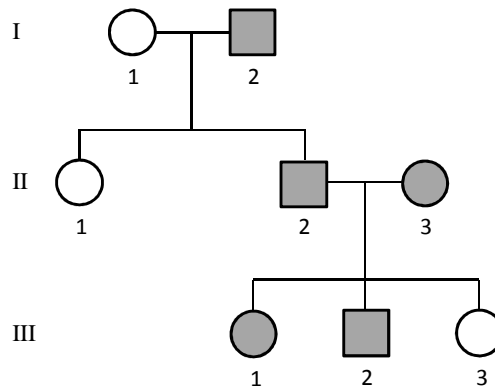


Figure 6

- 3.1. Use the data from the pedigree chart to deduce the genotype of the individuals listed below. Include alternative answers when the data provided in the pedigree chart may yield more than one possible genotype.

Individual	Genotype
I - 1	
I - 2	
II - 1	
II - 2	

Individual	Genotype
II - 3	
III - 1	
III - 2	
III - 3	

[five marks]

- 3.2. Calculate the expected genotypic and phenotypic ratios for the third generation, when II-2 mates with II-3? (Working must be shown).

[two marks]

3.3. What is the possibility that the cross in Question 3.2 results in an unaffected female?

[one mark]

[Total: eight marks]

4. The following question is about microscopy.

4.1. Figure 7 is a photomicrograph taken from an onion root tip. Label and annotate the cells in the photomicrograph to indicate the different stages of the cell cycle exhibited at this part of the root tip.

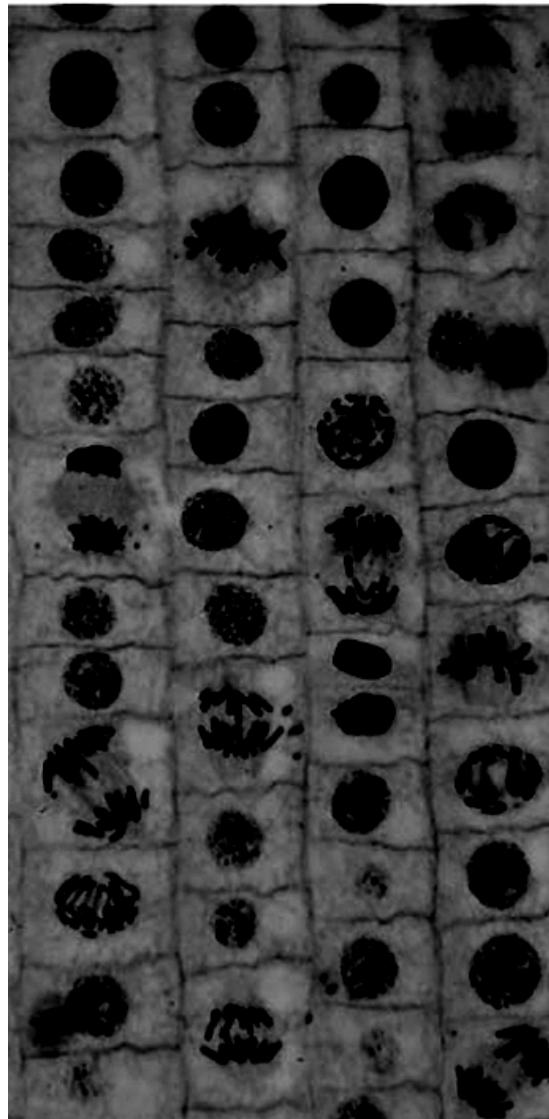


Figure 7

[five marks]

4.2. The photomicrographs below (Figure 8 and Figure 9) show two types of epithelial cells as seen under high power of a light microscope.

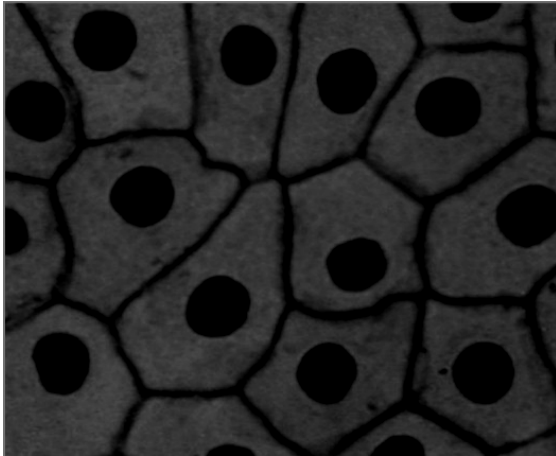


Figure 8 (surface view)



Figure 9 (transverse section)

(i) Identify the two types of epithelial cells represented in the figures above:

Figure 8: _____

Figure 9: _____

[two marks]

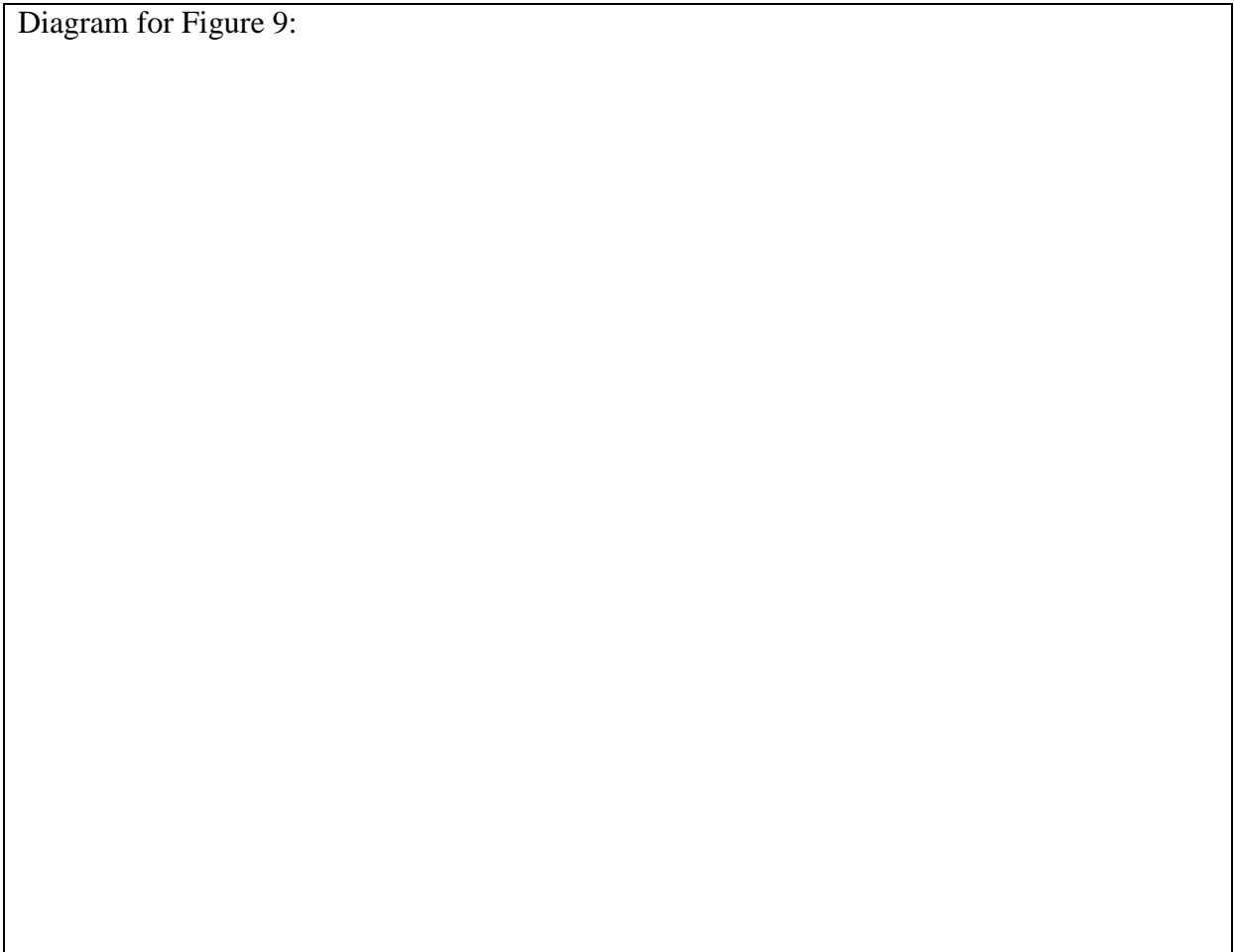
Use the spaces below to draw annotated diagrams of the epithelial cells represented above.

Diagram for Figure 8:

[four marks]

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Diagram for Figure 9:



[five marks]

[Total: sixteen marks]

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UNIVERSITY OF MALTA, MSIDA

MATRICULATION CERTIFICATE EXAMINATION

ADVANCED LEVEL

SEPTEMBER 2012

SUBJECT:	BIOLOGY
PAPER NUMBER:	IV – <i>Practical</i>
DATE:	31 st August 2012
TIME:	1 hour 30 minutes

Directions to Candidates

- Write your index number in the space at the top left-hand corner of this page.
 - Answer **ALL parts of the question**. Write all your answers in this booklet.
 - Marks allocated to parts of the question are indicated.
 - You are reminded of the necessity for good English and orderly presentation in your answers.
 - In calculations you are advised to show all the steps in your working, giving your answer at each stage.
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-

For examiners' use only:

Question	Total
Score	
Maximum	40

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1. Transpiration is the process by which plants lose water through evaporation from the leaves. It is possible to measure the amount of water lost by a plant quantitatively by measuring the rate at which it is taken up by the stem.

You are required to devise and implement an experiment to calculate the rate of transpiration of a leafy shoot, using the equipment provided:

- a. shoot of a leafy plant;
- b. rubber tubing;
- c. glass capillary tube;
- d. ruler;
- e. distilled water;
- f. large water container;
- g. various items of laboratory glassware and hardware.

- 1.1. What are the objectives of your experimental investigation?

[one mark]

- 1.2. Give a BRIEF general statement summarising the method through which your objectives will be investigated.

[two marks]

DO NOT WRITE ABOVE THIS LINE

1.4. Devise and compile a suitable **TABLE** for recording your results. Do not enter any results in the table at this stage. Use the space below for the results table.

--

[five marks]

Carry out the investigation that you devised in Question 1.3. and insert the results in the table you prepared in your answer to Question 1.4.

1.5. Draw a graph to present your results. *Use the graph paper provided in this booklet.*

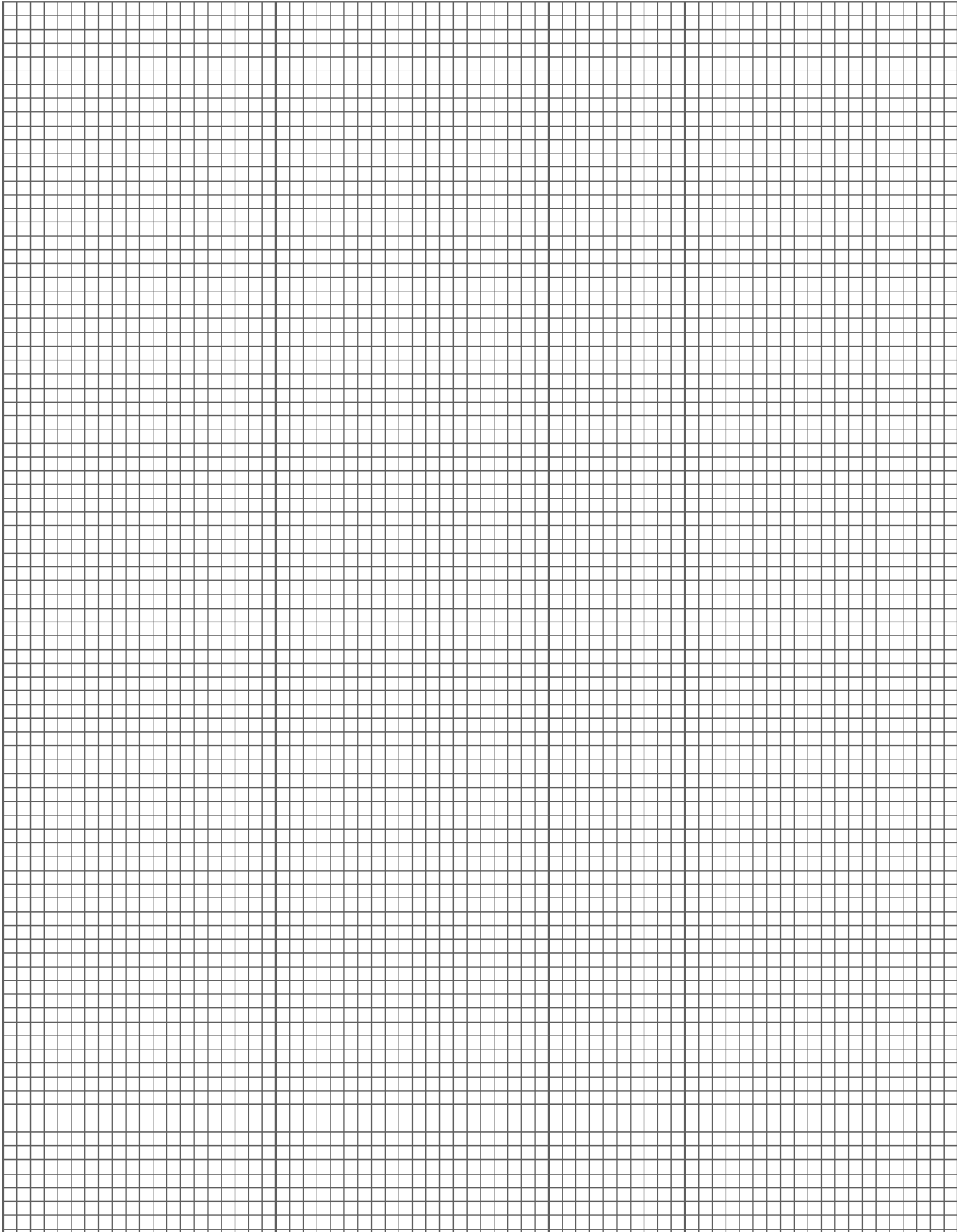
[five marks]

1.6. Calculate the rate of transpiration of your shoot in $\text{cm}^3 \text{hr}^{-1}$ given that the bore of the capillary tube has a radius of 0.05cm. (Equation: $\text{Volume} = \pi r^2 h$) (*note that $\pi=3.142$*)

[five marks]

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Graph Paper to be used in conjunction with Question 1.5.



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1.7. List and justify TWO relevant precautions that should be taken before the start of the experiment.

[two marks]

1.8. List and describe TWO sources of error that may have influenced your result.

[two marks]

1.9. What modifications would you do to your experimental set-up to vary the shoots' transpiration rate?

[one mark]

1.10. How would you expect transpiration to change following the modification named in Question 1.9.? Explain your answer.

[two marks]

[Total: forty marks]

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