

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD
UNIVERSITY OF MALTA, MSIDA
MATRICULATION EXAMINATION
ADVANCED LEVEL
MAY 2016

SUBJECT: BIOLOGY
PAPER NUMBER: I
DATE: 5th May 2016
TIME: 4.00 p.m. to 7.05 p.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.
- The use of electronic calculators is permitted.

For examiners' use only:

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

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1 This question is about taxonomy.

1.1 Why is it advantageous to have a system of classification for organisms?

[two marks]

1.2 Define the term *species*.

[two marks]

Euphorbia melitensis is an endemic flowering plant found in the Maltese Islands.

1.3 Identify **TWO** major taxonomical groups within the plant kingdom for *Euphorbia melitensis*.

[two marks]

1.4 *Euphorbia melitensis* is the scientific name of this plant. Mention **TWO** advantages of using the binomial system for naming organisms.

[two marks]

1.5 What do the following represent in the taxonomic rank?

1.5.i *Euphorbia*: _____

1.5.ii *melitensis*: _____

[two marks]

[Total: Ten marks]

2 This question is about biomolecules.

Figure 1 represents the molecular structure of ATP.

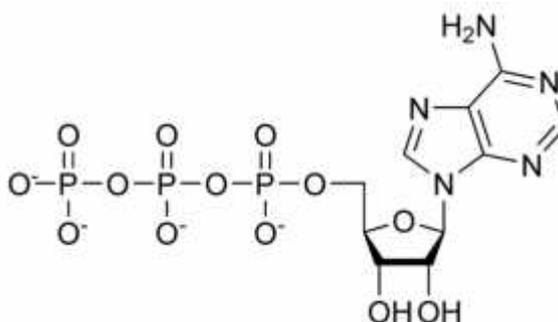


Figure 1: Molecular structure of ATP

(Source: http://chemwiki.ucdavis.edu/@api/deki/files/25707/800px-ATP_chemical_structure.png?revision=1)

2.1 What does ATP stand for?

_____ [one mark]

2.2 Mention **THREE** reasons why ATP is an optimal energy currency in living organisms.

_____ [three marks]

Proteins are made up of amino acids. Twenty amino acids make up polypeptides and proteins in animals.

2.3 What is an *amino acid*?

_____ [one mark]

2.4 Name the type of reaction that occurs when two amino acids form a dipeptide.

_____ [one mark]

Please turn the page.

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- 2.5 Valine and Glycine are two of the twenty amino acids found in animals. Their molecular structure is represented below in **Figure 2**.

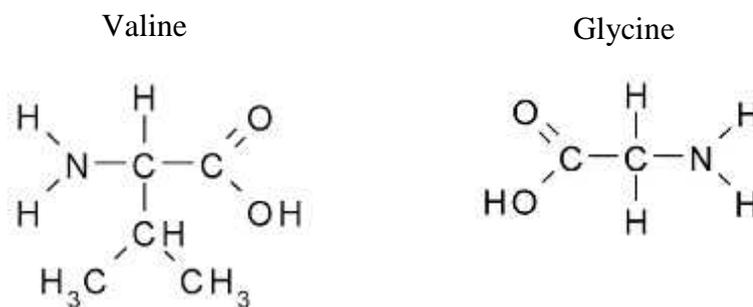
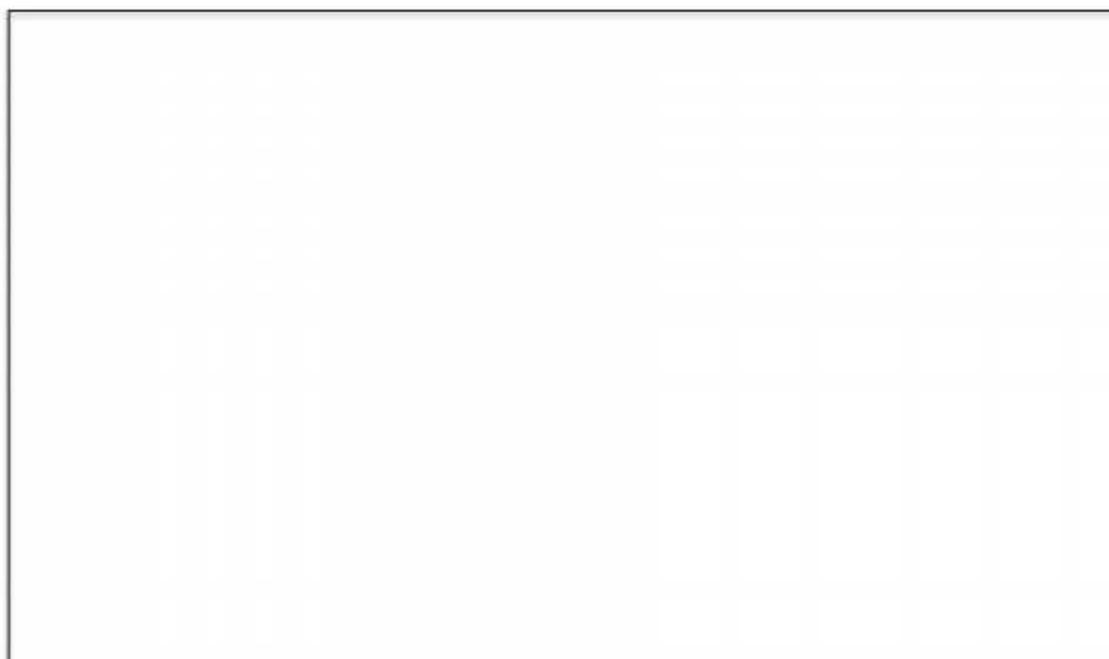


Figure 2: Molecular structure of valine and glycine

In the space below, draw the molecular structure of the dipeptide formed between these two molecules.



[two marks]

- 2.6.i Describe the primary structure of a protein.

[one mark]

- 2.6.ii What is the importance of the primary structure of a protein?

[one mark]

[Total: Ten marks]

DO NOT WRITE ABOVE THIS LINE

3 This question is about gaseous exchange.

3.1 List **TWO** characteristics of a respiratory surface.

[two marks]

3.2 How does the countercurrent system found in the gills of fish provide efficient gaseous exchange?

[three marks]

Neoparamoeba perurans is a parasite which causes amoebic gill disease in fish. This disease causes the lamellae to thicken and to fuse together.

3.3 Explain why these two effects give rise to a reduction in the efficiency of gaseous exchange in fish.

[two marks]

Please turn the page.

DO NOT WRITE ABOVE THIS LINE

- 3.4 Use the information in **Table 1** to calculate the volume of water that would have to pass over the gills every hour to provide a fish, weighing 0.6 kg, with the required oxygen. Show your working.

Table 1: Hypothetical features of gaseous exchange in fish at rest

Oxygen required by fish	$85 \text{ cm}^3 \text{ kg}^{-1} \text{ hour}^{-1}$
Volume of oxygen absorbed by the gills from each Litre of water	8 cm^3

Answer: _____

[three marks]

[Total: Ten marks]

- 4 This question is about hormonal control.
- 4.1 Which hormones are responsible for the regulation of blood glucose in the body?

[two marks]

An experiment was carried out to investigate how the blood glucose level fluctuates following ingestion of glucose.

At the start of the experiment, each member of a group of volunteers ingested a syrup containing 50 g of glucose. The concentration of glucose was determined in blood samples at intervals over a period of 2 hours. The results shown in the graph next page (**Figure 3**) are mean values for the group of volunteers.

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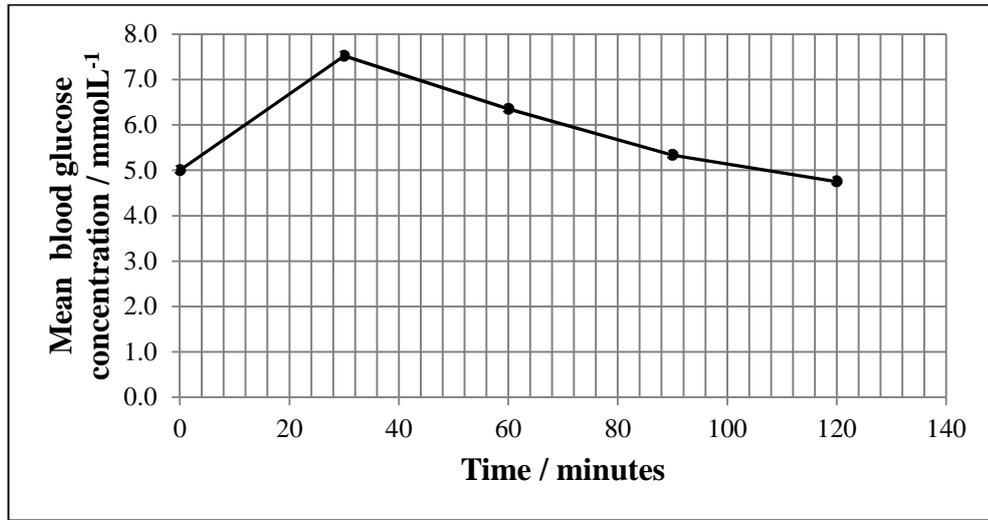


Figure 3: Graph showing mean blood glucose concentration versus time

4.2 Describe and explain the changes in the concentration of glucose during the following time intervals:

4.2.i 0 to 30 minutes

[three marks]

4.2.ii 30 to 120 minutes

[three marks]

[Total: Eight marks]

Please turn the page.

5 This question is about genetics.

5.1 Explain what is meant by the following terms:

5.1.i Allele:

[one mark]

5.1.ii Dominant:

[one mark]

5.1.iii Heterozygous:

[one mark]

5.1.iv Genotype:

[one mark]

5.2 *Melopsittacus undulatus*, commonly known as the budgerigar, is a small parrot which can have green, blue, yellow or white feathers.

Feather colour is controlled by two genes, B/b or Y/y according to the following genotypes:

Colour of bird	Genotype
Green	At least one dominant B allele and one dominant Y allele
Blue	At least one dominant allele B but are homozygous recessive for y
Yellow	At least one dominant allele Y but are homozygous recessive for b
White	Homozygous recessive for both b and y

DO NOT WRITE ABOVE THIS LINE

5.2.i If two green-feathered budgerigars which are heterozygous at both loci were crossed, what is the probability of producing offspring with blue feathers?
A genetic diagram should be included.

Probability: _____

[six marks]

5.2.ii Two blue budgerigars were crossed and over the years, they produced 22 offspring, five of which were white. Deduce the most likely genotypes for the two blue birds.

[four marks]

[Total: Fourteen marks]

Please turn the page.

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6 This question is about biotechnology.

6.1 Define *biotechnology*.

[one mark]

6.2 List the **FOUR** main stages that are employed in genetic engineering using bacteria.

[four marks]

6.3 The following techniques are crucial in analysing DNA organisation. Give the function of each:

Gel electrophoresis _____

Southern blotting _____

[two marks]

PCR is an important tool used in biotechnology.

6.4 What does PCR stand for?

[one mark]

6.5 Explain the function of PCR in biotechnology.

[two marks]
[Total: Ten marks]

DO NOT WRITE ABOVE THIS LINE

7 This question is about reproduction.

7.1 Briefly mention the main advantages and disadvantages of asexual reproduction.

[four marks]

7.2 The following hormones are involved in the control of the human menstrual cycle. For each hormone, state where it is produced and the organ/s on which it acts.
Oestrogen:

Progesterone:

[two marks]

The placenta plays an important role in pregnancy.

7.3 State **ONE** important role of the placenta in the:
7.3.i protection of the embryo.

[one mark]

7.3.ii nutrition of the embryo.

[one mark]

[Total: Eight marks]

Please turn the page.

DO NOT WRITE ABOVE THIS LINE

8 This question is about excretion and osmoregulation.

The water balance of the body in different situations was investigated. The results were recorded on three separate days, namely, a warm day, a cold day and a day during which the individual did heavy exercise (Figure 5). The total water intake by the body was the same as the water output in each situation.

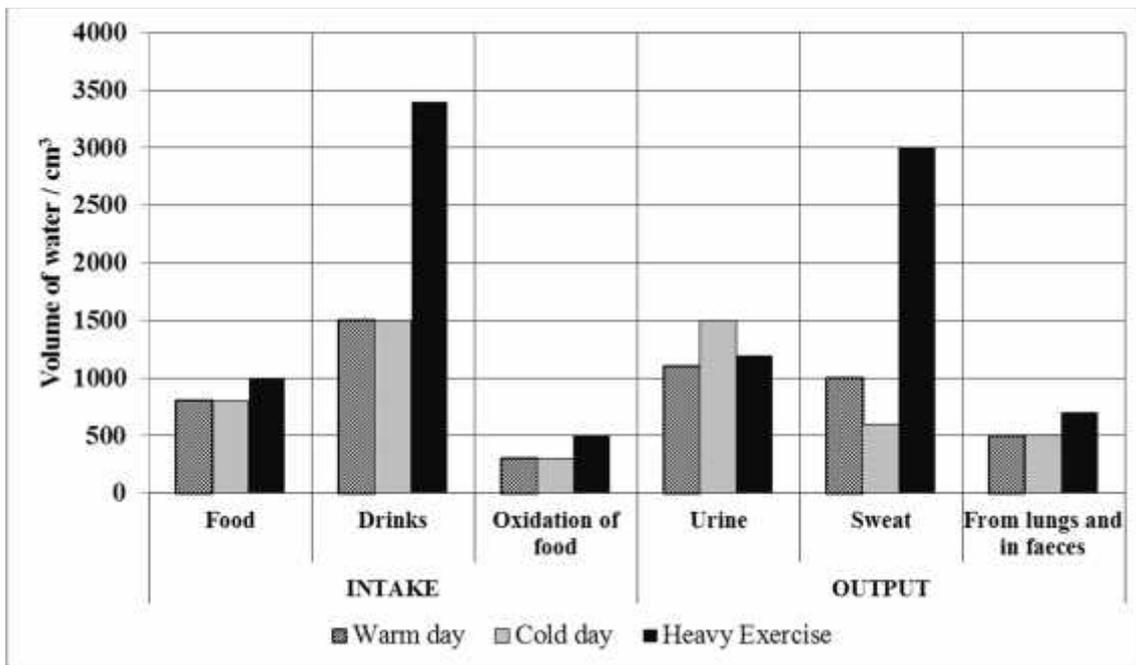


Figure 5: Water balance for 3 different days – a warm day, a cold day and a day whereby heavy exercise was performed.

8.1 Explain what is meant by oxidation of food and how it produces water in the body.

[two marks]

8.2.i Describe the difference in water output on the cold day and the day of heavy exercise.

[three marks]

DO NOT WRITE ABOVE THIS LINE

8.2.ii Explain what is causing these differences.

[two marks]

8.3 Explain why more water is produced by the oxidation of food on the day of heavy exercise.

[three marks]
[Total: Ten marks]

9 This question is about the immune system.

9.1 Explain the term *disease*.

[two marks]

An individual can acquire two types of immunity. **Table 6** represents the different types of immunity.

Table 6: Different types of immunity

Immunity	Type of immunity acquired	Production of memory cells / yes or no
Injection with an antibody against specific disease-causing organism		
Injection with a live, weakened disease-causing organism		

9.2 Complete **Table 6**.

[two marks]

Please turn the page.

DO NOT WRITE ABOVE THIS LINE

When a pathogen enters the body, a primary immune response occurs. This can include the production of antibodies.

9.3 Define the term *antibody*.

[two marks]

9.4 Describe the events in the immune response which lead to antibodies being produced.

[four marks]
[Total: Ten marks]

10 This question is about evolution.

10.1 Explain what is meant by *biological evolution*.

[two marks]

10.2 An important factor for natural selection to occur is the variation in the phenotypes of the population. Explain.

[three marks]

DO NOT WRITE ABOVE THIS LINE

10.3 Briefly differentiate between *sympatric* and *allopatric* speciation.

[two marks]

10.4 Briefly explain how geographic isolation can lead to the evolution of a new species.

[three marks]
[Total: Ten marks]

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UNIVERSITY OF MALTA, MSIDA
MATRICULATION EXAMINATION
ADVANCED LEVEL
MAY 2016

SUBJECT:	BIOLOGY
PAPER NUMBER:	II
DATE:	6 th May 2016
TIME:	9.00 a.m. to 12.05 p.m.

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.*
 - *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.*
-

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 the line numbers.

Insect-eating bats save global corn farmers €0.91 billion a year from crop damage

5 Corn is one of the most widely planted row crops in the world. Pests, such as the larvae of the corn earworm moth (*Helicoverpa zea*), cause substantial damage to the plants by eating corn ears (the part of the plant that contains the kernels), and leaves. This reduces crop yields and quality, and potentially affects food supply in some areas. Insect-eating bats, such as the North American eastern red bat (*Lasiurus borealis*), commonly forage on adult moths of crop pests, including the corn earworm. Now researchers have performed the first experimental study of the impact of bats on pest suppression in row crops.

10 The researchers built six enclosures over sections of corn fields in the Midwestern United States, and used removable netting to exclude bats from foraging for corn earworm moths at night. Over two growing seasons, the researchers compared pest damage in corn grown under the enclosures with damage to corn grown in identically sized neighbouring sections of the corn field.

15 The researchers discovered 59% more corn earworm larvae per ear of corn in sections of the corn field excluded from the bats compared with the control sections. This, they say, indicates that the bats can consume enough adult moth pests at night to directly reduce the number of corn earworm larvae that cause the corn damage. Corn excluded from foraging bats had 56% more damaged kernels per ear and more leaf damage when compared with corn ears in the control sections. By comparing the difference in undamaged kernels between the two types of section, the researchers calculated that the bats effectively increased corn yields by 1.4%.

20 The bats also had another, previously unknown, positive impact on crop protection — a reduction in fungal infections, which are introduced by corn earworm larvae damage. The researchers found 20% of the corn ears in enclosures were infected with fungi compared with 12% of the control ears. The main fungus was *Fusarium graminearum*, which produces fumonisin, a toxin which is harmful to livestock. Although fumonisin levels in these experiments were within safe levels for livestock, the researchers say this shows bats can play an important role in limiting fungal infections, which decrease the value of livestock crops.

Some countries have adopted genetically modified corn with insecticidal properties from *Bacillus thuringiensis* (Bt), to resist pests like the corn earworm larvae. However, non-Bt corn is still the dominant global type, and comprised 68% of corn planted globally in 2011.

30 Overall, the researchers say bats could boost the value of global corn crops by US\$ 1 billion (€0.91 billion) a year, based on the increased corn yields. This value could be higher if the benefits of suppressing fungal growth and reducing pesticide use are also included. As nocturnal flying insectivores, bats around the world occupy unique ecological niches. Bat species in both North America and Europe fill a similar trophic level, and can be predators of economically relevant crop pest species in many agroecosystems. However, they also face increasing threats from disease, mortality caused by increased numbers of wind turbines, and increasing agricultural intensification, which often results in the removal of natural habitat. This research highlights not only the ecological but the economic importance of bats in agriculture, and the need to protect bats from disease threats and the destruction of habitats.

Adapted from: "Science for Environment Policy": European Commission DG Environment News Alert Service, edited by SCU, The University of the West of England, Bristol.
http://ec.europa.eu/environment/integration/research/newsalert/pdf/insect_eating_bats_save_global_corn_farmers_091_billion_euros_a_year_from_crop_damage_438na2_en.pdf

- 1.1 Giving examples from the text, explain what is meant by the ecological term *community*.
[three marks]
- 1.2 What is understood by *trophic level* (line 33)?
[three marks]
- 1.3 What is meant by the term *control* (line 13)?
[three marks]
- 1.4 Give the Kingdom, Phylum and Class of the following two organisms listed in the text:
1.4.i Eastern red bat;
1.4.ii Corn earworm moth.
[three marks each]
- 1.5 Explain, in detail, the term *ecological niche*, as referred to in the phrase: “As nocturnal flying insectivores, bats around the world occupy unique ecological niches.” (lines 31, 32).
[four marks]
- 1.6 Give an example of *gene technology* from the text.
[two marks]
- 1.7 List **TWO** advantages and **TWO** risks that the application of genetically modified plants may have on the environment.
[four 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. Give an account of the various factors affecting the rate of enzyme-catalysed reactions.
3. Describe in detail the mechanisms used by plants to transport water along their tissues.
4. Animals and plants solve problems associated with mechanical support in different ways. Discuss.
5. Mitosis and meiosis are two processes of cellular division. Write in detail about the similarities and differences between these two processes.

[Total: Fifty marks]

Please turn the page.

SECTION C

Answer **ONE** question from this section.

6. Write brief notes on the **evolutionary significance** of the following:

- 6.1 The eukaryotic cell;
- 6.2 Sexual reproduction;
- 6.3 Anemophilous flowers;
- 6.4 Bilateral symmetry;
- 6.5 Respiratory pigments in animals.

[five marks each]

7. Use your knowledge of biology to distinguish between the following pairs:

- 7.1 Gross primary production and net primary production;
- 7.2 Hibernation and aestivation;
- 7.3 The gametophyte and sporophyte stages in plants;
- 7.4 Sympathetic nervous system and parasympathetic nervous system;
- 7.5 Coelomate and acoelomate body plans.

[five marks each]

[Total: Twenty five marks]

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UNIVERSITY OF MALTA, MSIDA
MATRICULATION EXAMINATION
ADVANCED LEVEL
MAY 2016

SUBJECT:	BIOLOGY
PAPER NUMBER:	III
DATE:	6 th May 2016
TIME:	4.00 p.m. to 5.35 p.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.*
- *The use of electronic calculators is permitted.*

For examiners' use only:

Question	1	2	3	Total
Score				
Maximum	16	19	15	50

-
1. This question is about ecology.
- 1.1 A study was carried out to determine the population size of the endemic Balearic lizard *Podarcis lilfordi*, in three islets in the south coast of Mallorca (Spain); Es Caragol, Na Guardia and Na Moltona. Given the geographical features of the area of study, lizard populations of these islets could be considered as three separate closed populations. In this regard, the **capture-recapture method** was considered suitable for the purpose of this study.

1.1.i Briefly describe the technique which is used to capture and mark the organism in question.

[two marks]

1.1.ii List **TWO** precautions that should be taken during marking, to make sure that it does not interfere with the study.

[two marks]

1.1.iii **Table 1** shows the data collected from the three islets during the study.

Table 1: Capture – Recapture Method Results

(Adapted from: Ruiz de Infante Anton, J., Rotger, A., Igual, J. M., and Tavecchia, G. (2014) Estimating lizard population density: an empirical comparison between line-transect and capture–recapture methods. *Wildlife Research* 40, 552–560)

	Es Caragol	Na Guardia	Na Moltona
<i>First sampling session</i>			
Number of lizards captured	170	315	400
<i>Second sampling session</i>			
Total number of lizards recaptured	140	295	450
Number of marked lizards	34	35	25
<i>Area (hectares)</i>	0.29	1.98	5.09

Estimate the size of each islet population, using the Lincoln Index:

$$N = \frac{n_1 \times n_2}{m}$$

where:

N = estimated population size;

n₁ = number of individuals captured during the first sampling session;

n₂ = number of individuals recaptured during the second sampling session;

m = number of marked individuals in recaptured sample.

Show your working.

[three marks]

Please turn the page.

1.1.iv Which islet has the highest population density of *Podarcis lilfordi*? Explain your answer.

[three marks]

1.1.v Why could the islets be assumed to be closed populations for the purpose of this study?

[two marks]

1.1.vi To increase the viability of this method, the time lapse between the first capture and the recapture must be very small compared to the life span of the organism being sampled. Explain.

[one mark]

1.1.vii List **THREE** limitations of the capture-recapture technique.

[three marks]
[Total: Sixteen marks]

Please turn the page.

2. This question is about photosynthesis

2.1 In an experiment to determine the effect of light intensity on the rate of photosynthesis, the apparatus depicted in **Figure 1** was set up. The rate of photosynthesis was estimated using the number of bubbles produced by the pondweed per minute. Light intensity was measured as the distance of the pondweed from the lamp.

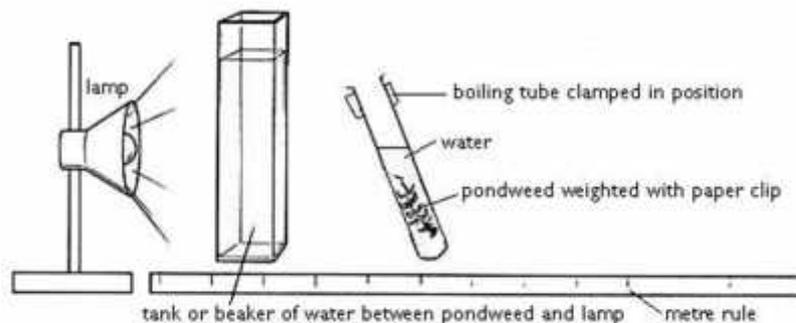


Figure 1: Experiment determining how light intensity affects the photosynthetic rate.

(Source: <http://www.nuffieldfoundation.org/practical-biology/investigating-factors-affecting-rate-photosynthesis>)

2.1.i Give **TWO** assumptions that are being made in this experiment.

[two marks]

2.1.ii Name **TWO** limiting factors apart from light intensity that might affect this experiment.

[two marks]

2.1.iii What is the function of the tank of water which is placed between the pondweed and the lamp?

[one mark]

Typical results of this experiment are shown in **Figure 2**.

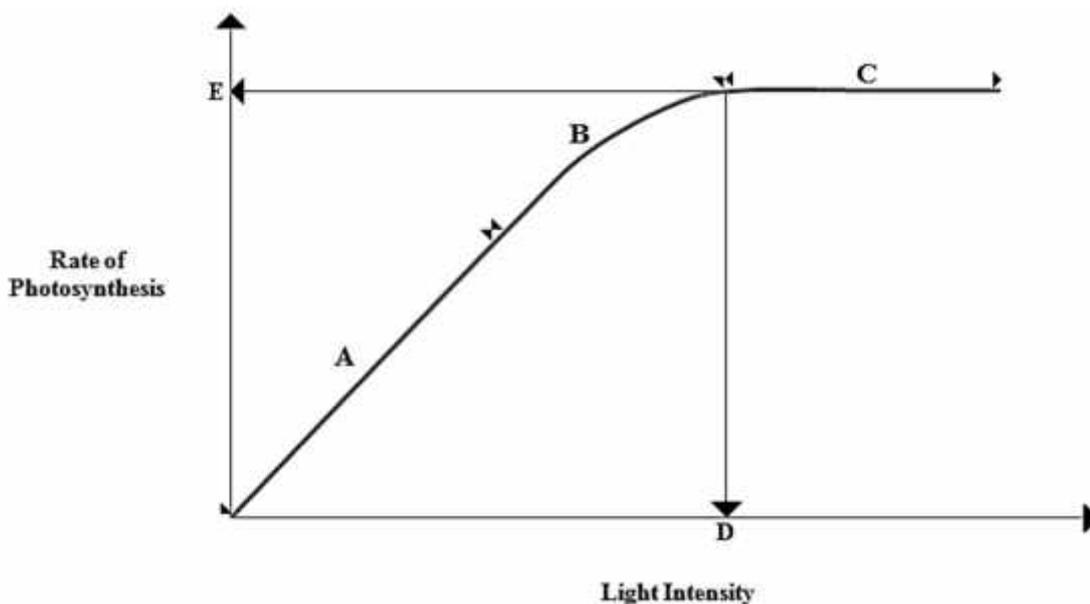


Figure 2: Effect of light intensity on the rate of photosynthesis

2.1.iv Briefly discuss whether light intensity is the major limiting factor in regions A, B and C of the curve.

[three marks]

2.1.v What do points D and E represent?

[two marks]

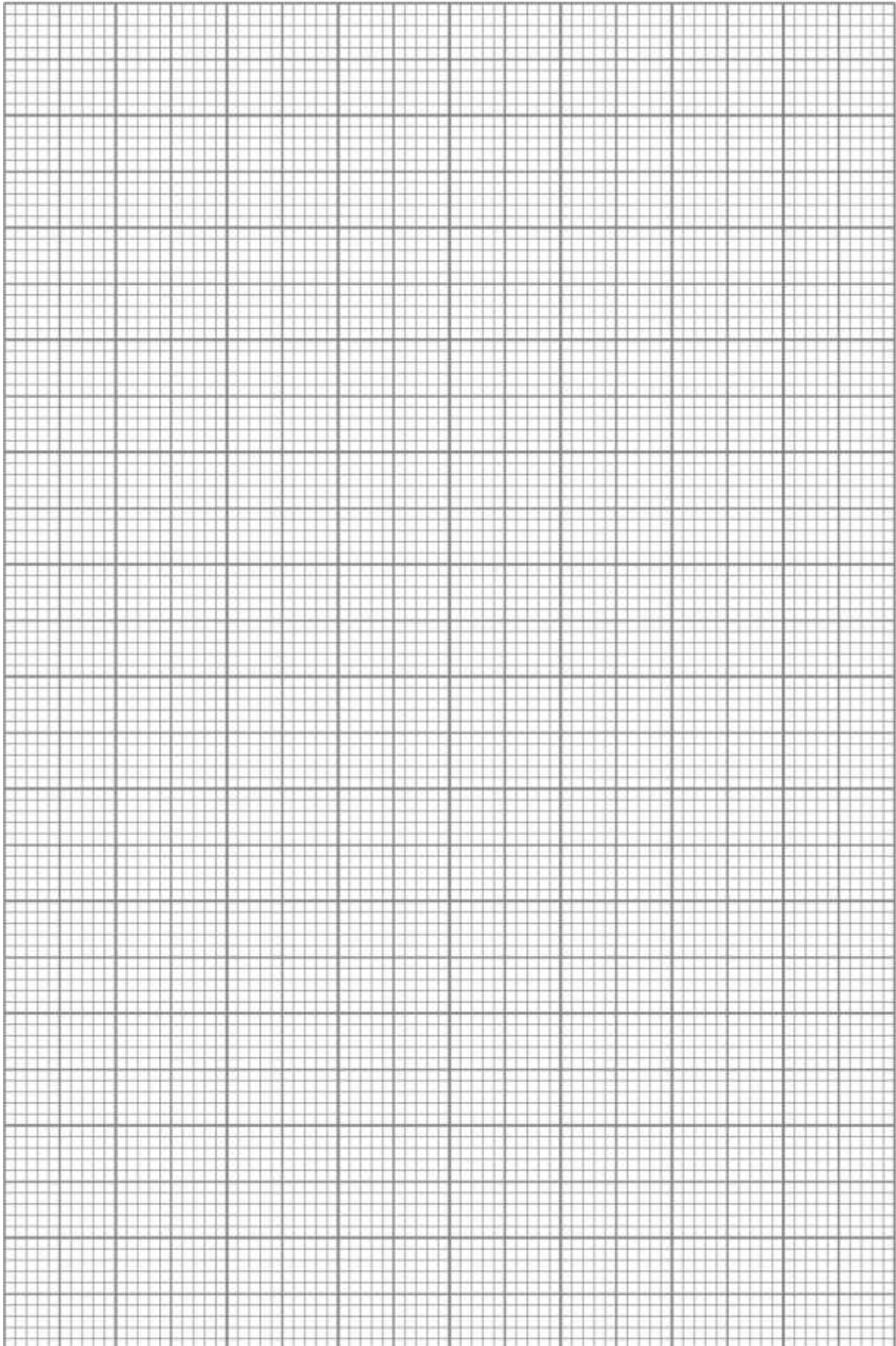
- 2.2 An experiment was carried out to study the exchange of carbon dioxide between the atmosphere and two plant species (species I and species II) over a range of light intensities. The temperature was kept constant throughout the course of the experiment, and the net carbon dioxide absorption by each plant species was recorded and tabulated in **Table 2** below.

Table 2: Net Absorption of Carbon Dioxide during Photosynthesis

Light intensity (%)	Net carbon dioxide absorption in arbitrary units	
	Species I	Species II
0	-0.9	-0.2
10	-0.8	-0.1
20	-0.6	+1.2
30	-0.4	+3.0
40	+1.4	+5.5
50	+2.6	+6.1
60	+4.8	+6.2
70	+5.7	+6.3
80	+6.9	+6.3
90	+7.7	+6.3
100	+8.5	+6.3

- 2.2.i Using the same scale and axes, plot graphs of net carbon dioxide absorption with light intensity for both plant species I and II. Use the graph paper provided.

[five marks]



2.2.ii Explain what is happening in the two plant species when the light intensity is between 70% and 80%.

[two marks]

2.2.iii Use the graph to determine the light intensities at which plant species I and II reach compensation point.

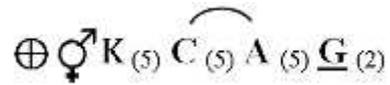
Species I: _____

Species II: _____

[two marks]

[Total: Nineteen marks]

3. This question is about flowering plants.
- 3.1 This is the floral formula for a flower belonging to the family Solanaceae.



Candidates are to note that K is sometimes substituted by Ca and C by Co.

- 3.1.i Use the information provided in this floral formula to construct the floral diagram of this flower.

[five marks]

- 3.1.ii What is the sexuality of this flower?

[one mark]

- 3.1.iii What does the floral formula infer about the composition and position of the gynaecium?

[two marks]

- 3.1.iv What is the biological term for the type of symmetry that this flower exhibits?

[one mark]

3.2 **Figure 3** shows the half-flower diagram of White Deadnettle (*Lamium album*).

3.2.i Label the flower parts shown in this diagram.

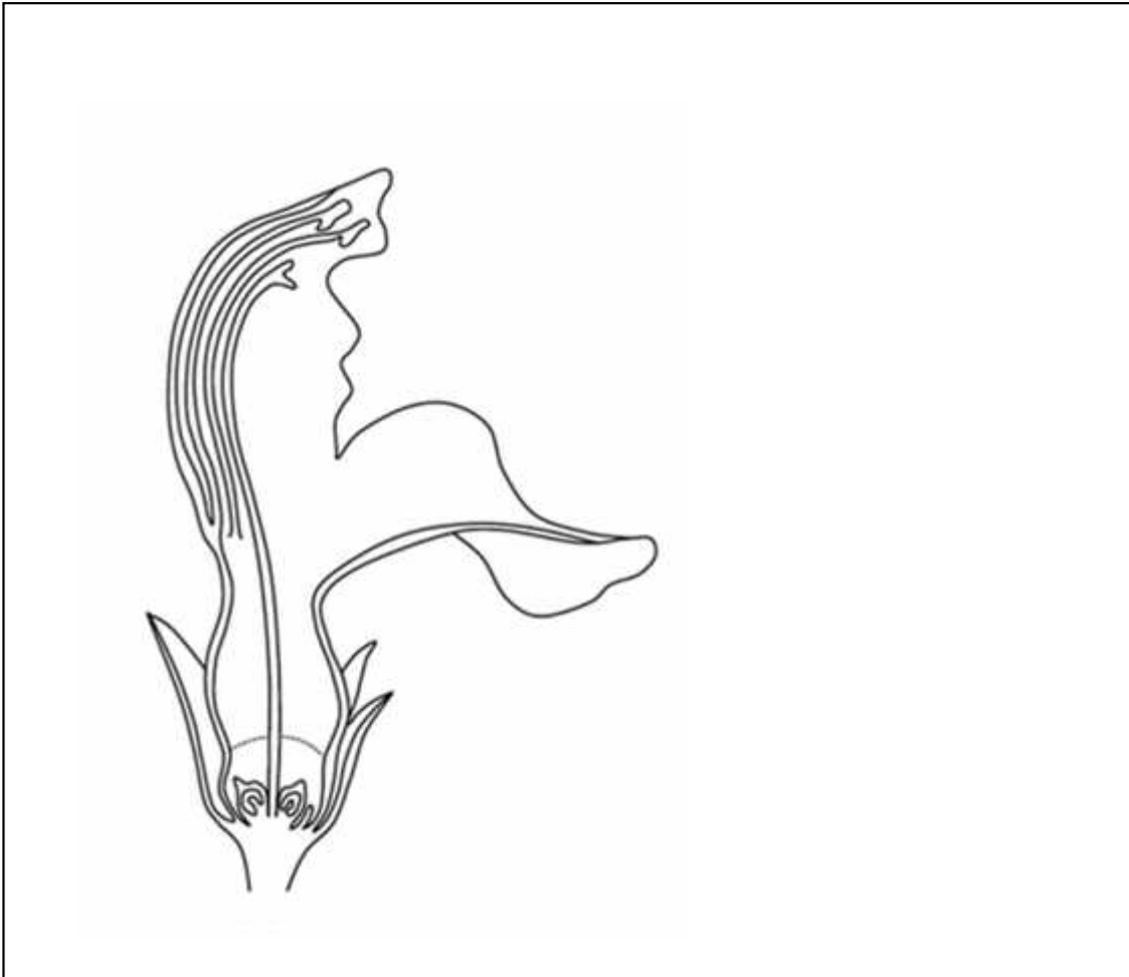


Figure 3: Half-flower Diagram of *Lamium album*
(Adapted from: http://cronodon.com/images/lamium_album_female_half_flower.jpg)

[four marks]

3.2.ii *Lamium album* is an entomophilous flower. Give **TWO** characteristics visible in **Figure 3** that are associated with this kind of pollination.

[two marks]

[Total: Fifteen marks]

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UNIVERSITY OF MALTA, MSIDA
MATRICULATION EXAMINATION
ADVANCED LEVEL
MAY 2016

SUBJECT:	BIOLOGY
PAPER NUMBER:	IV – <i>Practical</i>
DATE:	3 rd June 2016
TIME:	1 hr 35 min

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. Drawings of biological material and graphical representations of data are to be made on the appropriate pages within this booklet.
 - The marks allotted to parts of 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.
 - The use of electronic calculators is permitted.
-

For examiners' use only:

Question	Total
Score	
Maximum	40

Betalains are natural pigments found in a variety of plants. Betacyanin is one such pigment found in the vacuole of beetroot cells. When the membrane is damaged, this pigment can cross the vacuole membrane and cell membrane and leak out into the surrounding area. The intensity of the red colour is an indication of the release of betacyanin from the beetroot cells.

You are required to devise and implement an experimental procedure to comparatively investigate the effect of some reagents on the release of betacyanin from the cells of the beetroot (*Beta vulgaris*).

You are provided with the following materials:

- Beetroot strips (*Beta vulgaris*);
- 50% ethanol solution;
- 1% solution of a household detergent;
- 15% sodium chloride solution;
- A sheet of white paper;
- Other laboratory apparatus as required.

1.1 Suggest a suitable null hypothesis for this investigation.

[two marks]

1.2 Using the material provided, devise and describe an experimental procedure that comparatively investigates the effect of ethanol, detergent and sodium chloride on the release of betacyanin.

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.

--

[four marks]

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

1.5 From YOUR results, deduce whether the null hypothesis you suggested in Question 1.1 is valid.

[four marks]

DO NOT WRITE ABOVE THIS LINE

1.6 *Interpret* the results that you obtained.

1.6.i Detergent:

[two marks]

1.6.ii Ethanol:

[two marks]

1.6.iii Sodium chloride:

[two marks]

1.7 List **TWO** possible sources of error in your investigation.

[two marks]

1.8 Briefly describe **TWO** modifications you would do to your experimental set-up to produce more reliable results.

[two marks]
[Total: Forty marks]

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