Index No.:_____ **AM 05/I.13s**

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

UNIVERSITY OF MALTA, MSIDA

MATRICULATION EXAMINATION
ADVANCED LEVEL
SEPTEMBER 2013

SUBJECT:	BIOLOGY
PAPER NUMBER:	I
DATE:	3rd September 2013
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	10	11	15	12	12	7	14	7	12	**100**

1. Give short explanations to describe the following observations:

1.1. Skeletal muscle cells have a high proportion of mitochondria.

_____

_____

_____

[two marks]

1.2. Erythrocytes lack most of the organelles.

_____

_____

_____

[two marks]

1.3. Specialized proteins prevent substances from moving through spaces between the epithelial cells of the intestine.

_____

_____

_____

[two marks]

1.4. Connections between plant cells allow symplastic movement of substances.

_____

_____

_____

[two marks]

1.5. Cnida are found in jellyfish.

_____

_____

_____

[two marks]
[Total: ten marks]

2. This question is about biomolecules and transport through the cell membrane.

2.1. The diagram below (Figure 1) represents the structure of a small protein.

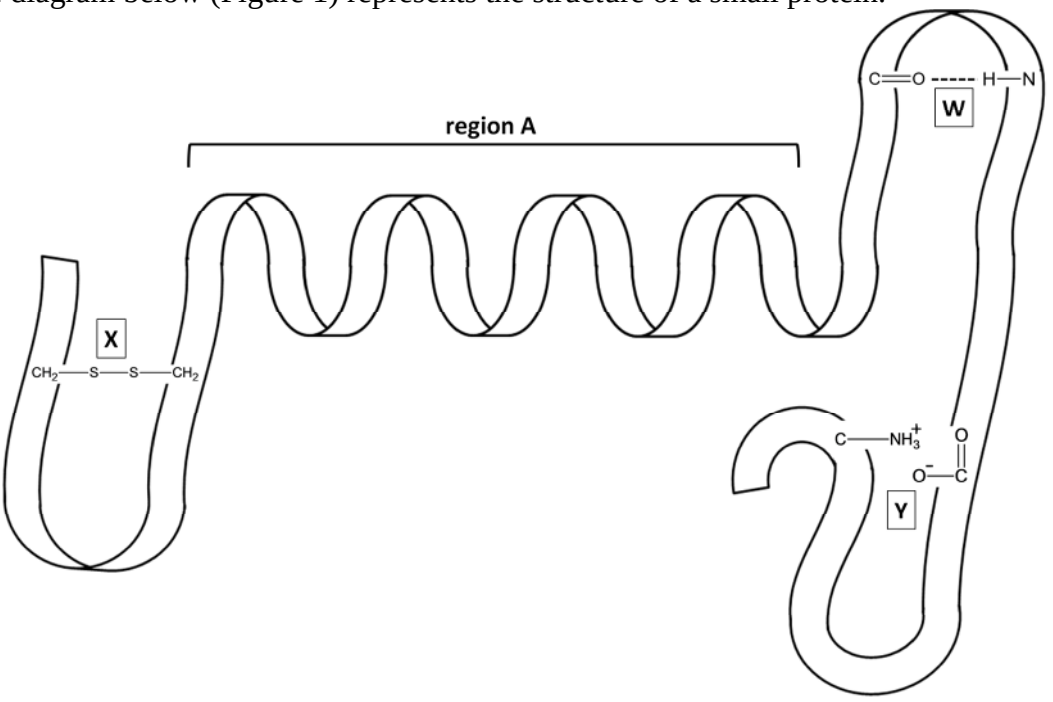


Figure 1.

i. Name the four types of bonds present in the protein above.

Description	Type of bond
bond holding the primary structure of proteins	
bond **W**	
bond **X**	
bond **Y**	

[four marks]

ii. Part of the protein is labelled as **region A**. What type of secondary structure does **region A** have, and what type of bonding gives rise to this structure?

_____

[one mark]

iii. What is the highest level of protein structure shown in the diagram?

_____

[one mark]

2.2. Some molecules are transported across cell membranes by diffusion. Name **TWO** factors which influence the rate of diffusion across cell membranes.

_____

_____

[one mark]

2.3. Vitamins are small molecules that are required for the correct functioning of the body. Different vitamins are transported across the cell membrane via different processes. Given that Vitamin C is water-soluble and Vitamin D is fat-soluble, explain the possible uptake process for each respective vitamin across the cell membrane.

Vitamin C:_____

_____

_____

Vitamin D:_____

_____

_____

[four marks]
[Total: eleven marks]

3. This question is about digestion.

3.1. Relate the following to their biological function:

i. *gastric glands* in the stomach;

_____

_____

_____

[two marks]

ii. *microvilli* in the small intestine;

_____

_____

_____

[two marks]

iii. *circular* and *longitudinal muscles* in the ileum;

_____

_____

_____

[two marks]

iv. *non-pathogenic bacteria* in the large intestine of humans;

_____

_____

_____

[two marks]

v. *four-chambered stomach* in ruminants.

_____

_____

_____

[two marks]

3.2. The table below lists five enzymes associated with digestion in humans. Complete the table below by giving their source, substrate and product/s of their action.

Enzyme	**Source**	**Substrate** → **Product/s**
Lipase		→
Lactase		→
Sucrase		→
Maltase		→
Enterokinase		→

[five marks]

[Total: fifteen marks]

4. The following question is about blood vessels and circulation.
The diagram below (Figure 2) shows three simplified cross-sections of different types of blood vessels.

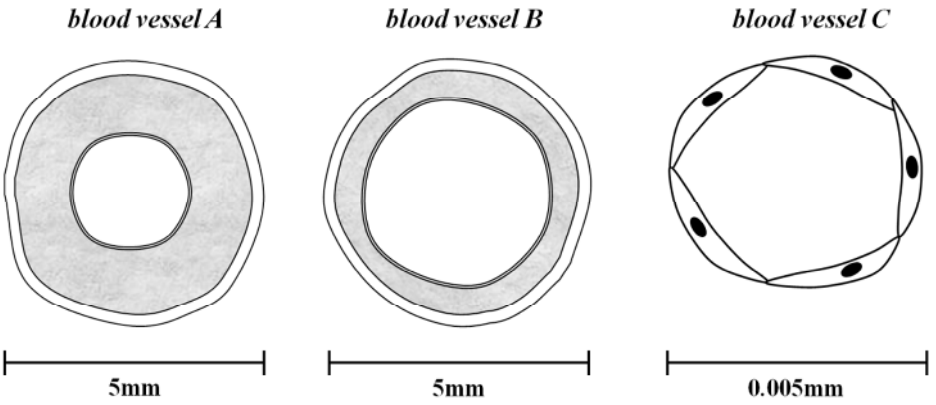


Figure 2.

4.1. Name *blood vessel A* and *blood vessel B.*

A: _____ B: _____

[one mark]

4.2. Describe **ONE** anatomical feature visible in the diagrams above that can be used to distinguish between *blood vessel A* and *blood vessel B.*

_____

_____

_____

[two marks]

4.3. What is the role of muscle contraction on the flow of blood within *blood vessel B.*

_____

_____

_____

[two marks]

4.4. Describe **TWO** structural features that enable *blood vessel C* to form tissue fluid.

_____

_____

_____

[two marks]

4.5. The chemical composition of blood plasma is very similar to that of tissue fluid. Name **ONE** difference in their chemical composition.

_____

[one marks]

4.6. Describe **ONE** function of tissue fluid.

_____

_____

[one mark]

4.7. When tissue fluid is not efficiently reabsorbed, it collects in tissues causing swelling (oedema). Give **ONE** physiological condition that could cause oedema.

_____

[one mark]

4.8. Describe **TWO** ways how the cardiovascular system and lymphatic system are dependent on each other.

_____

_____

_____

_____

[two marks]
[Total: twelve marks]

5. The following question is about genetics.

5.1. Distinguish between the following pairs of terms:

i. *autosomal linkage* and *sex linkage*;

_____

_____

_____

[two marks]

ii. *anaphase I* and *anaphase II* in meiosis;

[two marks]

iii. *kinetochore* and *centromere*;

[two marks]

iv. *continuous* and *discontinuous variation.*

[two marks]

5.2. Give **ONE** function for each of the following enzymes used during DNA replication.

Enzyme	Function during DNA replication
i. *Helicase*	
ii. *Primase*	
iii. *DNA polymerase III*	
iv. *DNA ligase*	

[four marks]
[Total: twelve marks]

6. The following question is about biotechnology.

The flow chart below (Figure 3) shows how a genetically modified organism may be produced by inserting a gene from a human into a bacterium.

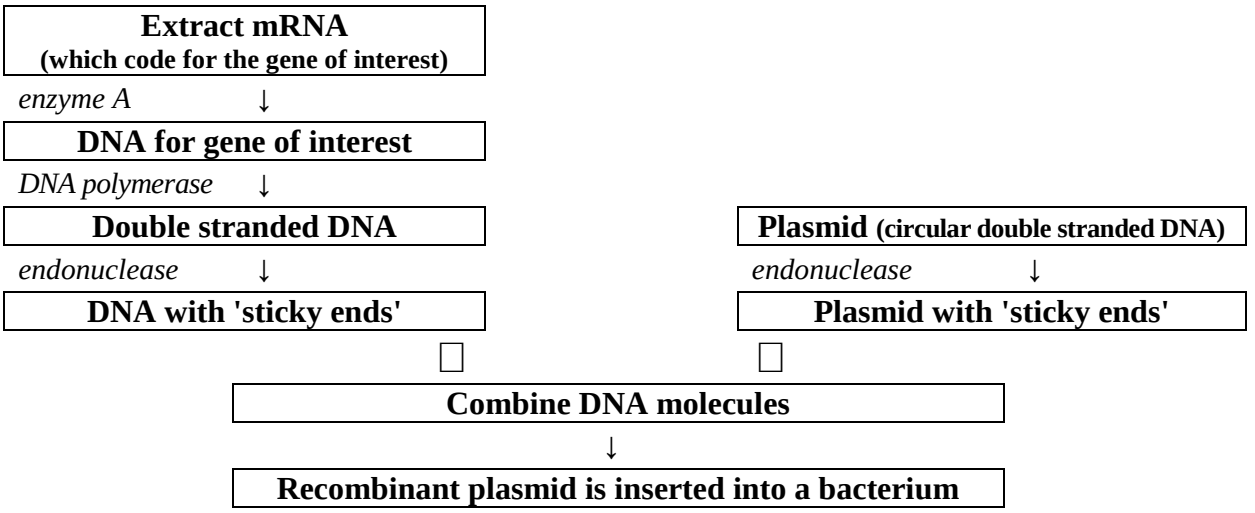


Figure 3.

6.1. Name *enzyme A.*

_____

[one mark]

6.2. Describe how treating DNA with *endonuclease* produces sticky ends.

_____

_____

_____

[two marks]

6.3. Explain the importance of sticky ends in the formation of recombinant DNA.

_____

_____

_____

[two marks]

6.4. Apart from the gene of interest, an antibiotic resistance gene was simultaneously inserted into the plasmids. Then the recombinant plasmids were inserted into bacterial cells, and these cells were allowed to grow in a Petri dish. Explain how the antibiotic resistance gene can be used to distinguish bacterial cells that are carrying recombinant plasmids from those which do not.

_____

_____

_____

[two mark]
[Total: seven marks]

7. This question is about the ornithine cycle and excretion.

7.1. Briefly explain the importance of the ornithine cycle.

_____

_____

[one mark]

7.2. Which is the main organ responsible in carrying out the ornithine cycle?

_____

[one mark]

7.3. Draw a diagram to illustrate the main steps involved in the ornithine cycle (molecular structures and sites in the cell where each reaction takes place are not required).

[five marks]

7.4. The kangaroo rat is a small rodent capable to survive long periods in very dry conditions by eating seeds without the need of drinking water. In a laboratory experiment, the weight of three kangaroo rats was recorded over a period of 10 days, with each individual being given a specific diet.

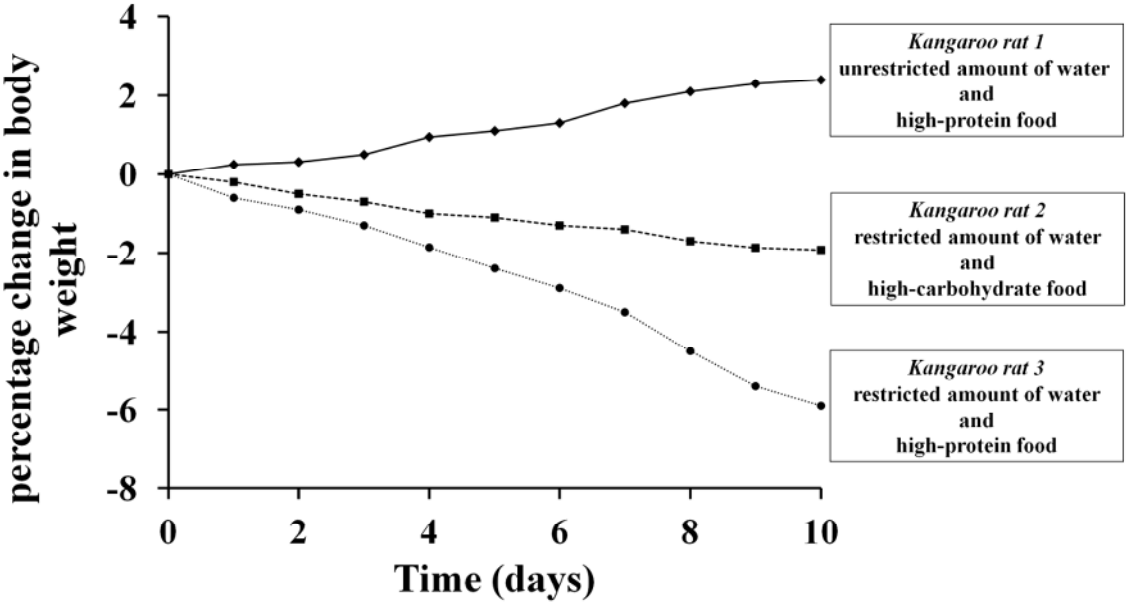


Figure 4.The graph above shows how the percentage weight of three kangaroo rats changed with time. The diets given to each respective kangaroo rat is indicated at the right side of the graph.

i. Briefly suggest why ***kangaroo rat 3*** has lost a substantial amount of its body weight while ***kangaroo rat 1*** did not.

_____

_____

_____

[two marks]

ii. Briefly suggest why ***kangaroo rat 2*** has lost weight at a much slower rate than ***kangaroo rat 3***.

_____

_____

_____

[two marks]

iii. Explain why the Loop of Henle in kangaroo rats is significantly longer than that found in humans.

_____

_____

_____

_____

[three marks]

[Total: fourteen marks]

8. This question is about the nitrogen cycle. The diagram below (Figure 5) shows different chemical forms in which nitrogen is found.

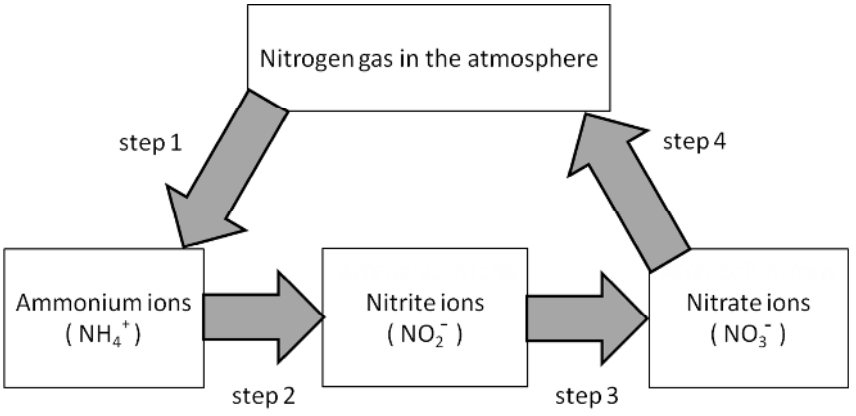


Figure 5

8.1. Step 1 involves the bacteria of the genus *Azotobacter*. This bacterium makes use of the enzyme nitrogenase to convert nitrogen gas into ammonium ions. In a laboratory investigation, it was noted that this enzyme's activity was linked to the ammonium ion concentration present, and was concluded that nitrogenase behaves as an inducible enzyme.

Explain how one would expect the nitrogenase activity to change as the ammonium ion concentration increases.

_____

_____

_____

[two marks]

8.2. Another genus of bacteria capable of performing step 1 is *Rhizobium*. This bacterium has a mutualistic relationship with plants. Explain the term *mutualism* with reference to *Rhizobium* and plants.

_____

_____

_____

[two mark]

8.3. Name a bacterium genus responsible for step 2 and another for step 3.

genus for step 2: _____

genus for step 3: _____

[one mark]

8.4. What type of bacteria carry out step 4 and under which conditions do these bacteria convert nitrate to nitrogen gas?

_____

_____

[two marks]
[Total: seven marks]

9. Briefly explain the following statements related to the life cycle of plants.

9.1. In bryophytes the dominant generation is the gametophyte.

_____

_____

_____

_____

[three marks]

9.2. In ferns, the prothallus plays an important role in gamete formation.

_____

_____

_____

_____

[three marks]

9.3. Pollen grains transferred by insects are different from those transferred by wind.

_____

_____

_____

_____

[three marks]

9.4. Vegetative propagation ensures the survival of seedless plants but reduces the species' genetic diversity.

_____

_____

_____

_____

[three marks]
[Total: twelve marks]

BLANK PAGE

BLANK PAGE

AM 05/II.13s

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

UNIVERSITY OF MALTA, MSIDA

MATRICULATION EXAMINATION
ADVANCED LEVEL
SEPTEMBER 2013

SUBJECT:	BIOLOGY
PAPER NUMBER:	II
DATE:	4th September 2013
TIME:	9.00 a.m. to 12.00 noon

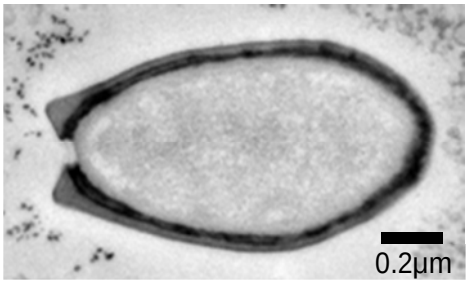
Directions to Candidates

- *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.*
- *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 and afterwards, use your knowledge of biology to answer the questions that follow. The numerals in the left-hand margin are line numbers.

Giant viruses



An electron microscopy image of a *Pandoravirus* (adapted from **Nature** doi:10.1038/nature.2013.13410)

Jean-Michel Claverie and Chantal Abergel, the two evolutionary biologists who helped in the discovery of the giant virus *Megavirus chilensis* (discovered in 2010), have just discovered the largest virus known from a sample of water collected off the coast of Chile. This virus was called *Pandoravirus salinus* and it appeared to be infecting amoebae. After a few months a similar virus, which was later named *Pandravirus dulcis*, was found in a pond in Australia. Under the electron microscope, researchers observed that these giant viruses were taken up by amoeba host cells. Then, they followed a viral life cycle, eventually splitting their host cells open. The Pandoraviruses discovered were around 1 micrometre long and 0.5 micrometres across, and their respective genomes (composed of DNA) were around 2.5 million and 1.9 million bases, making them the largest viruses ever found, larger than many bacteria and even larger than some eukaryotic cells.

These viruses, are more than mere record-breakers - they also hint at unknown parts of the tree of life, with just 7% of their genes matching those in existing genetic databases. Consequently scientists are looking forward to see what would come out of the genetic content of these two giant viruses. Characterization of the unknown genes and the proteins they encode for, could lead to a better understanding of the origin of viruses. These scientists have long suspected that giant viruses evolved from cells. If they are right, then, ancestors of Pandoraviruses must have been very different from the prokaryotes and eukaryotes we have today. “We think that at some point, the dynasty on Earth was much bigger than the currently known domains (major taxonomic ranks),” says Abergel. 'Some cells gave rise to modern life, and others survived by parasitising them and evolving into viruses.'

Virologists stated that this major discovery substantially expands the complexity of viruses and confirms that viral diversity is still largely underexplored. In fact scientists had previously mistaken these large viruses for parasitic or mutualistic bacteria. In 2008, a parasitologist found one within an amoeba and said that “after reading this stunning article, I recognised that both *P. salinus* and *P. dulcis* are almost identical to what we described a few years ago. We had no idea that those giant organisms could be viruses at all.”

This discovery suggests that scientists may revise their concept of what a virus looks like. “After reading the article, many people may wonder if they have something on their shelves that might be a giant virus,” says Abergel.

***Adapted from: Nature,* July 2013 (doi:10.1038/nature.2013.13410)**

1.1. It has been frequently stated that viruses 'live a borrowed life' and are considered border-line between living and non-living. Give **FOUR** reasons why they are considered as non-living.

[two marks]

1.2. By means of simple labelled diagrams, describe the structure of a typical bacteriophage and a typical retrovirus.

[five marks]

1.3. Name **TWO** differences between the viruses named in Question 1.2. and the Pandoraviruses described in this article.

[two marks]

1.4. Describe the main steps involved in the *viral life cycle* mentioned in line 10.

[four marks]

1.5. The long-standing view about the origin of viruses is that they are the result of 'escaped' host genes that acquired a protein coat, and therefore do not fit in the general concept of biological species. Discuss how the discovery of these giant viruses might alter our view of the evolutionary biology of viruses.

[three marks]

1.6. The Pandoraviruses discovered do not affect human health but rather they are confined to fresh water bodies or sediments. Give **ONE** reason for this statement.

[one mark]

1.7. Suggest why scientists might have initially mistaken the Pandoraviruses for parasitic bacteria (lines 26 - 27).

[two marks]

1.8. Viruses are not typically considered as beneficial. Describe **ONE** situation where they are beneficial to humans.

[two marks]

1.9. It is said that mutualistic bacteria (line 27) have played an important role in the formation of eukaryotic cells. Give biological evidence that supports this statement.

[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. Write an account on biological countercurrent systems.

3. Carbon is the fundamental building block of material in living organisms. Discuss.

4. Write an essay on the mechanisms involved in the transmission of nerve impulses.

5. Write an account on protein synthesis.

[Total: fifty marks]

SECTION C

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

6. Use your knowledge of biology to explain the evolutionary importance of the following:

6.1. radial symmetry in sessile animals;
6.2. triploblastic organisation in animals;
6.3. closed circulatory system in fish;
6.4. lungs in terrestrial vertebrates;
6.5. tagmatisation in insects.

[five marks each]

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

7.1. Antibiotics are sometimes prescribed against influenza.
7.2. Complement proteins are an important component of the human immune system.
7.3. Positive feedback mechanisms are rare in nature.
7.4. Double fertilization in angiosperms involves the fusion of more than two nuclei.
7.5. Invasive alien species are a significant threat to biodiversity.

[five marks each]

[Total: twenty five marks]

Index Number:_____ **AM 05/III.13s**

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

UNIVERSITY OF MALTA, MSIDA

MATRICULATION EXAMINATION
ADVANCED LEVEL
SEPTEMBER 2013

SUBJECT:	BIOLOGY
PAPER NUMBER:	III
DATE:	5th September 2013
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	**Total**
Score				
Maximum	**20**	**15**	**15**	**50**

1. A marine ecologist intended to compare the abundance of attached shoreline seaweeds in polluted and unpolluted sites along the coast of the Maltese Islands. The ecologist selected ten coastal sites, five of which were impacted by pollution and five of which were unpolluted. The polluted sites were labelled P1-P5 and the unpolluted sites were labelled U1-U5. The ecologist visited each site and positioned a 0.5m x 0.5m quadrat on the shoreline. She measured the percentage cover of each of nine species of seaweed within the quadrat and recorded the results. The quadrat data was only recorded once from each site. The ecologist subsequently used the data to identify 'indicator species' that would be typical of either polluted sites or unpolluted sites. The results are recorded in Table 1.

Table 1: Percentage cover in quadrat of nine seaweed species

Site	***Jania***	***Cladophora***	***Ulva***	***Enteromorpha***	***Dictyota***	***Polysiphonia***	***Cystoseira***	***Callithamnion***	***Corallina***
P1	20	15	10	20	5	10	0	0	10
P2	20	10	5	20	0	10	0	5	10
P3	25	15	20	20	0	10	0	0	0
P4	20	10	25	25	0	5	0	0	5
P5	20	15	10	30	5	10	0	0	5
U1	25	5	5	5	15	5	20	0	10
U2	20	0	5	0	10	5	15	30	0
U3	25	0	0	0	5	10	20	15	5
U4	25	5	0	5	20	10	15	5	10
U5	20	5	0	0	30	5	15	5	5

1.1 The total coverage of seaweed in each quadrat did not add up to 100%. Suggest a possible reason for this.

[two marks]

The ecologist intends to compare the abundances of *Jania* and *Polysiphonia* using a *t*-test.

1.2 What is a *t*-test?

[two marks]

1.3 List THREE assumptions that should be satisfied when using a *t*-test.

[three marks]

1.4 Use the data in Table 1 to identify TWO indicator species of polluted sites and TWO indicator species of unpolluted sites.

Polluted sites:

Unpolluted sites:

[four marks]

1.5 Why is *Jania* not a suitable indicator species for either type of site?

[two marks]

1.6 Identify ONE significant limitation in the design of this investigation, and briefly explain how the ecologist could overcome this limitation.

[three marks]

1.7 The ecologist plans a follow-up survey in which she will investigate the changes in the distribution of seaweeds with increasing perpendicular distance away from the shoreline. Suggest and briefly describe, a sampling technique that would be suitable for this purpose

[four marks]
[Total: twenty marks]

2. Various regulations on commercial fishing specify that only larger fish may be retained after being caught. If smaller fish are caught, these are to be thrown back into the sea. A fisheries biologist hypothesises, based on evolutionary principles, that this would lead to a gradual reduction in the mean size of fish in wild populations.

In order to test this hypothesis, the biologist set up a number of seawater tanks, each containing 1000 fish of approximately uniform size. The fish were allowed to grow for one year and, just before the onset of the reproductive period, 90% of the fish in each tank were harvested (removed). In some tanks, the fish that were harvested were caught at random whilst in other tanks, only the largest fish or the smallest fish were harvested. The fish that were not harvested were allowed to reproduce. The experiment proceeded for four years, corresponding to four generations of fish. The results at the end of the experiment were as follows:

Table 2

		Mean weight of fish in each generation (g)			
Tank	**Fish harvested**	**Generation 1**	**Generation 2**	**Generation 3**	**Generation 4**
S1	Smallest 90%	3.1	3.5	3.8	4.2
S2	Smallest 90%	3.0	3.1	3.5	4.5
S3	Smallest 90%	2.8	3.4	3.7	4.3
R1	90% at Random	2.9	3.2	3.2	3.1
R2	90% at Random	3.2	2.9	3.1	3.0
R3	90% at Random	3.1	3.0	2.9	2.9
L1	Largest 90%	3.0	3.0	2.7	2.4
L2	Largest 90%	3.0	2.9	2.8	2.2
L3	Largest 90%	2.8	2.9	2.8	2.8

2.1 Suggest a suitable null hypothesis for this investigation.

[two marks]

2.2 Why was more than one tank used for each harvesting treatment?

[two marks]

2.3 Design, and fill in, a data table summarising the results shown in Table 2. Use the space below for your answer.

[five marks]

2.4 What general trends do the results suggest?

[three marks]

2.5 What form, or forms, of evolutionary selection occurred during this experiment?

[two marks]

2.6 List ONE limitation of this experiment.

[one mark]
[Total: fifteen marks]

3. During a study on the Twinflower (*Linnaea borealis*), a botanist acquired some fresh specimens and dissected them in order to observe their structure. The results were recorded as drawings, Figure 1 to Figure 3.

Figure 1: General structure of inflorescence
(Image source: Thomé - Flora von Deutschland, Österreich und der Schweiz 1885)

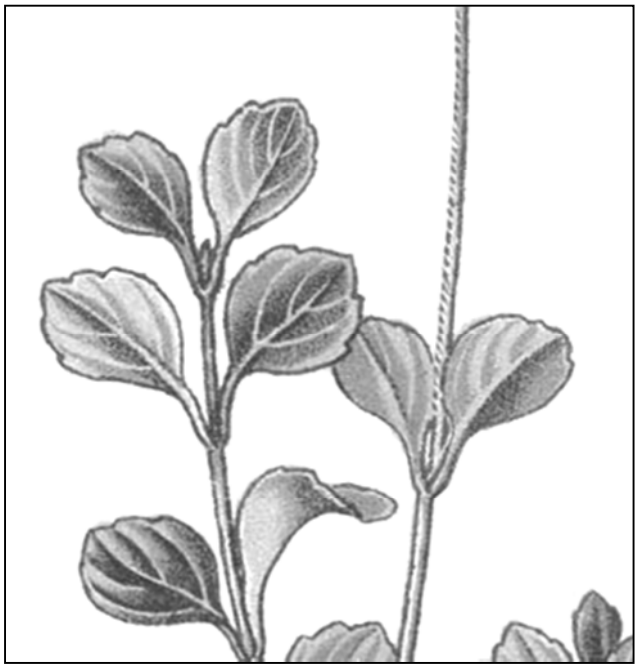


Figure 2: Leaves of *Linnaea borealis*
(Image source: Thomé - Flora von Deutschland, Österreich und der Schweiz 1885)

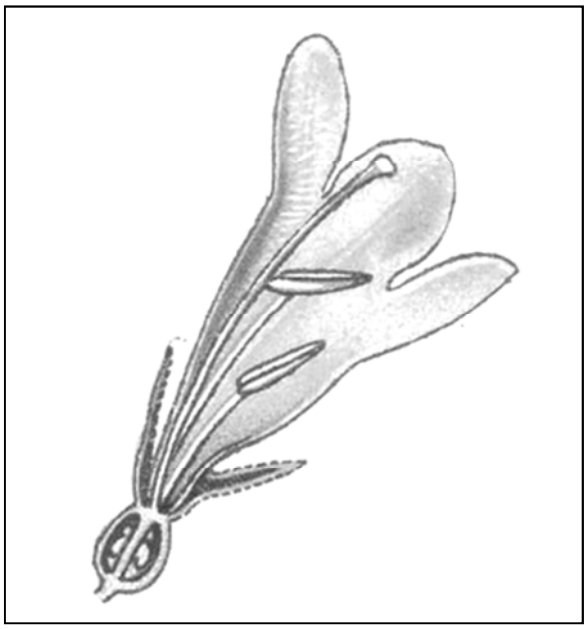


Figure 3: Half-flower showing reproductive structures
(Image source: Thomé - Flora von Deutschland, Österreich und der Schweiz 1885)

3.1 Distinguish between the terms ‘flower’ and ‘inflorescence’.

[two marks]

3.2 Is *Linnaea borealis* a dicotyledonous or monocotyledonous plant? Give TWO reasons for your answer.

[three marks]

3.3 What symmetry is shown by the flower of *Linnaea borealis*?

[one mark]

3.4 Is *Linnaea borealis* likely to be wind-pollinated or insect-pollinated? Give a reason for your answer.

[two marks]

3.5 Draw a labelled half-flower diagram based on the information in Figure 3. Use the space below for your drawing. No annotations are required.

[seven marks]
[Total: fifteen marks]

Index No.:_____ **AM 05/IV.13s**

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

UNIVERSITY OF MALTA, MSIDA

MATRICULATION EXAMINATION
ADVANCED LEVEL
SEPTEMBER 2013

SUBJECT:	BIOLOGY
PAPER NUMBER:	IV – *Practical*
DATE:	30th August 2013
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. Drawings of biological material and graphical representations of data are to be made on the appropriate pages within 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	Total
Score	
Maximum	40

1. The process of ripening in fruits involves the gradual conversion of storage carbohydrates, such as starch, into reducing sugars. Detection of the onset and rate of the ripening process in fruit is of prime importance for fruit growers as ripe fruit would usually be considered unsuited to long-range transport.

   You are provided with four samples of macerated banana, each sample derived from a different banana. You are required to devise and implement an experiment that would enable you to distinguish between the stage of ripening of each sample. Use the concentration of reducing sugar in the samples as an indicator of the stage of ripening.

   You are provided with the following:
   - Four samples of macerated banana (labelled A to D);
   - Benedict's Reagent;
   - Distilled water;
   - Various items of laboratory glassware and hardware.

   Candidates are advised to use 2 millilitres of any suspension, solution or reagent required during the experiment.

1.1 Suggest a suitable null hypothesis for this investigation.

[two marks]

1.2 Devise and describe an experimental procedure that may be used to compare the concentration of reducing sugars in each of the four samples. Your answer should refer to the following:
   (a) Procedure for testing for reducing sugars;
   (b) Preparation of a control solution;
   (c) Assessment of concentration of reducing sugars in each solution.

DO NOT WRITE ABOVE THIS LINE

[twenty marks]

1.3 List and justify **TWO** precautions taken before the start of the experiment.

[four marks]

1.4 Carry out the experiment that you devised and compile the results in the space below. Marks will be awarded for the structure and organisation of the data table.

[four marks]

1.5 What conclusions can be drawn from your results?

[four marks]

1.6 List and describe **TWO** sources of error that may be influencing your results.

[four marks]

1.7 Suggest, and briefly describe, another simple chemical test that would enable fruit growers to determine the stage of ripening of fruit.

[two marks]
[Total: forty marks]

BLANK PAGE

BLANK PAGE

BLANK PAGE