Index No.:_____ **AM 05/I.14m**

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

UNIVERSITY OF MALTA, MSIDA

MATRICULATION EXAMINATION
ADVANCED LEVEL
May 2014

SUBJECT:	BIOLOGY
PAPER NUMBER:	I
DATE:	14th May 2014
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	10	**Total**
Score											
Maximum	7	8	6	14	9	18	8	13	8	9	**100**

1. Figure 1 is a diagrammatic representation of a plasma membrane.

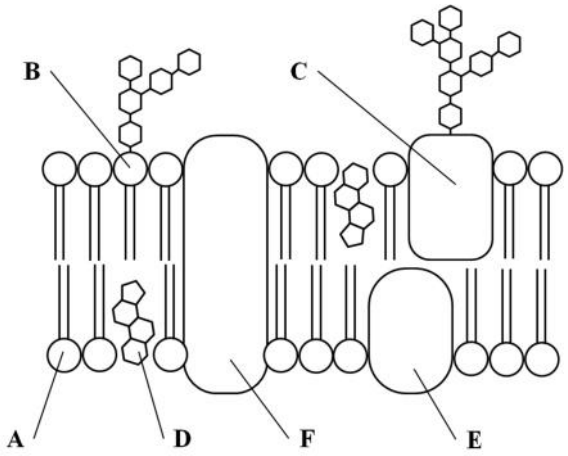
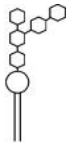
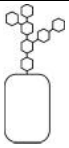
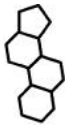
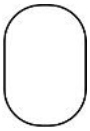


Figure 1

1.1 Name the biomolecules labelled A to E and give ONE function for each.

Label	Structure	ONE function
A 		
B 		
C 		
D 		
E 		

[five marks]

1.2 The protein labelled F is involved in facilitated diffusion across the cell membrane. Mention TWO ways in which facilitated diffusion differs from active transport.

_____

_____

[two marks]
[Total: seven marks]

2. Starch is the main storage carbohydrate found in plant cells. It consists of many monosaccharide molecules bound together after condensation reactions.

2.1 Name and draw the ring structure of the monomer that makes up starch.

Name of monomer: _____

[two marks]

2.2 Give THREE reasons on how the structure of starch relates to its biological function.

_____

_____

_____

_____

[three marks]

2.3 Cellulose is another polysaccharide found in plants. List TWO structural differences between starch and cellulose.

_____

_____

_____

[two marks]

2.4 Cellulose is a potential source of carbohydrate, yet only a few organisms are able to metabolise this polysaccharide. Explain this statement.

_____

_____

[one mark]
[Total: eight marks]

3. Briefly explain the following statements related to the structure and function of enzymes.

3.1 Enzyme activity can be affected by a minor change in its amino acid sequence.

_____

_____

_____

[two marks]

3.2 Prosthetic groups play an important role in the function of certain enzymes.

_____

_____

_____

[two marks]

3.3 Bacteria living in hot water vents have enzymes that are rich in disulfide bonds.

_____

_____

_____

[two marks]
[Total: six marks]

4. Myoglobin and haemoglobin are two respiratory pigments found in humans. The graph below (Figure 2) shows the oxygen dissociation curves for myoglobin and adult human haemoglobin.

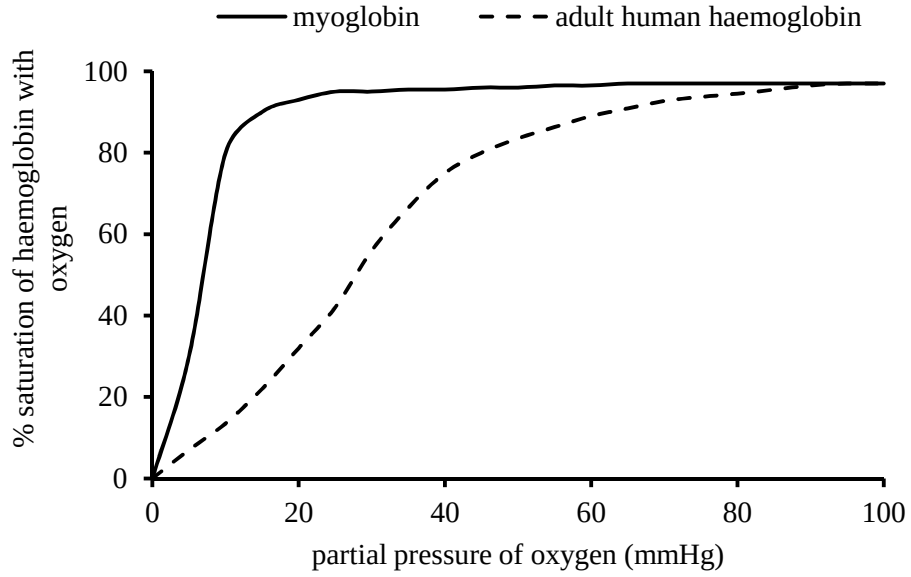


Figure 2

4.1 What is the main function of a respiratory pigment?

_____

_____

[one mark]

4.2 List THREE characteristics of haemoglobin that make it a very good respiratory pigment.

_____

_____

_____

[three marks]

4.3 By referring to Figure 2, explain how myoglobin is able to perform its function within an organism.

_____

_____

_____

[two marks]

4.4 During physical exercise the muscles produce more carbon dioxide than when at rest. Using Figure 2, draw a curve to illustrate how an increase in carbon dioxide causes a change in the oxygen dissociation curve of haemoglobin.

[one mark]

4.5 How does the change mentioned in Question 4.4 relate to the physiological requirements during physical exercise?

_____

_____

_____

[two marks]

Different animals have evolved slightly different haemoglobin molecules leading to different oxygen dissociation curves (Figure 3).

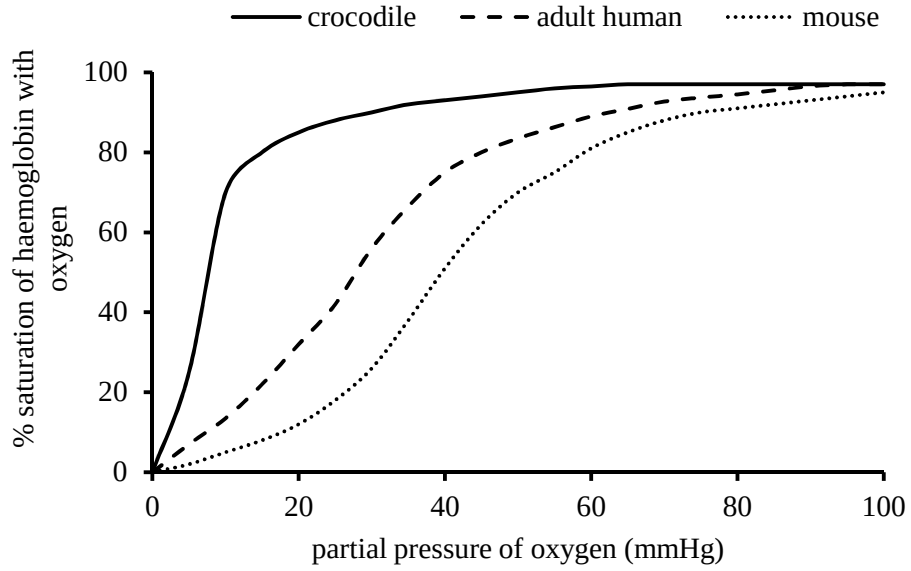


Figure 3

4.6 (i) What does Figure 3 indicate about the oxygen affinity of the crocodile haemoglobin when compared to human haemoglobin?

_____

_____

[one mark]

(ii) Explain how the shape of the oxygen dissociation curve of crocodile haemoglobin (Figure 3) enables the animal to remain immersed underwater for long periods of time without resurfacing to breathe.

_____

_____

_____

[two marks]

4.7 Even though humans and mice live in similar environmental conditions, yet their oxygen dissociation curves are not the same (Figure 3). Explain why the haemoglobin of these two mammals exhibit different affinities to oxygen.

_____

_____

_____

[two marks]
[Total: fourteen marks]

5. This question is about the main diagnostic features within the Animal Kingdom.

5.1 Fill in the table by identifying a phylum for each given description (a phylum may be used more than once).

Description	**Phylum**
Animals which possess tagmata and jointed limbs	
Animals which are bilaterally symmetrical and acoelomate	
Animals with chaetae and metameric segmentation	
Animals having secondary radial symmetry	
Animals possessing a notochord	
Animals with a mantle which usually secretes a shell	
Animals which are diploblastic and have radial symmetry	
Animals which possess pentadactyl limbs	

[four marks]

5.2 Define the following terms:

(i) metameric segmentation;

_____

_____

[one mark]

(ii) tagmata;

_____

_____

[one mark]

(iii) acoelomate;

_____

_____

[one mark]

(iv) secondary radial symmetry;

_____

_____

[one mark]

(v) diploblastic.

_____

_____

[one mark]

[Total: nine marks]

6. This question is about nervous and hormonal coordination.

6.1 Distinguish between the following terms:

(i) *motor neuron* and *sensory neuron*;

_____

_____

_____

[two marks]

(ii) *depolarisation* and *repolarisation*;

_____

_____

_____

[two marks]

(iii) *absolute refractory period* and *relative refractory period*;

_____

_____

_____

[two marks]

(iv) *sympathetic nervous system* and *parasympathetic nervous system*;

_____

_____

_____

[two marks]

(v) *monosynaptic reflex* and *polysynaptic reflex*.

_____

_____

_____

[two marks]

6.2 The table below lists eight hormones found in humans. Complete the table by indicating the site of secretion and mention ONE function for each named hormone.

Hormone	**Site of secretion**	**One main function**
Adrenaline		
Aldosterone		
Antidiuretic hormone		
Cortisol		
Insulin		
Luteinising hormone		
Oxytocin		
Secretin		

[eight marks]

[Total: eighteen marks]

7. Pesticides have been widely used to control populations of insect pests. A farmer sprayed a pesticide over a field at a concentration of 10 parts per million. After 6 months, there was a sudden increase in the mortality rate of the predatory birds living in the area. When tested, the concentration of the pesticide within these birds was found to be 2 parts per thousand.

7.1 Explain why the concentration of the pesticide within the predatory birds was much higher than that sprayed by the farmer.

_____

_____

[one mark]

7.2 After spraying the field with the same pesticide for four consecutive years, the farmer noted that very few insect species were being killed by the pesticide. Explain why the efficiency of the pesticide decreased after a number of years.

_____

_____

_____

[two marks]

Biotechnology has been used to develop plants that are able to produce insecticidal toxins such as Delta-toxin. Through gene technology, it is possible to isolate the gene responsible for the production of the toxin from the bacterium *Bacillus thuringiensis*. This gene is then transferred into crops such as the tomato plants. Figure 4 represents a simplified procedure for the processes involved in the production of such plants.

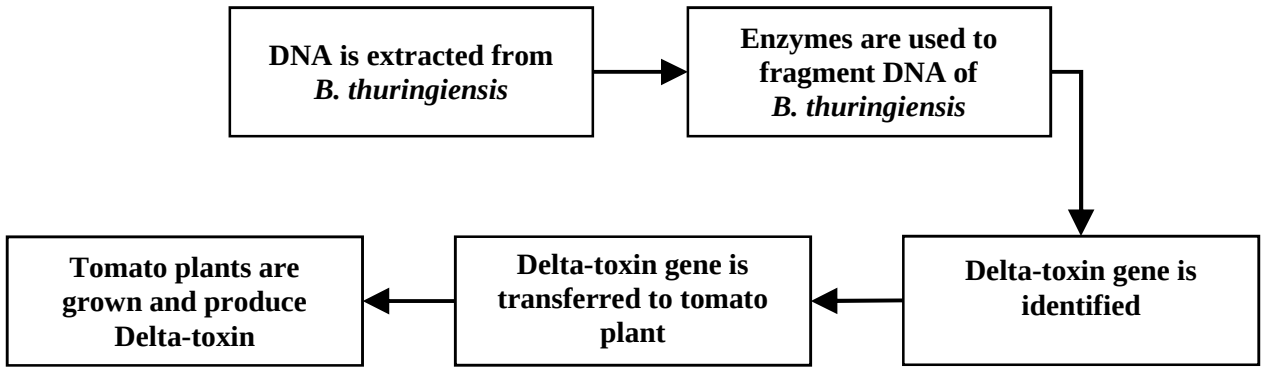


Figure 4

7.3 Name a type of enzyme that can be used to fragment the DNA of *B. thuringiensis.*

_____

[one mark]

7.4 Briefly outline a technique that may be used to transfer the gene coding for Delta-toxin into tomato cells.

_____

_____

_____

[two marks]

7.5 Give ONE environmental advantage and ONE environmental disadvantage of growing tomato plants that are able to produce Delta-toxins.

Advantage: _____

_____

Disadvantage: _____

_____

[two marks]
[Total: eight marks]

8. In general the life cycle of a cell consists of three main phases: interphase; nuclear division; and cytokinesis.

8.1 Mention TWO ways in which the chromosomes at the end of meiosis I would be different from those at the end of mitosis.

_____

_____

_____

[two marks]

8.2 Cytokinesis in plant cells uses a different mechanism from that used by animal cells. Briefly explain this statement.

_____

_____

_____

_____

[three marks]

During certain stages of the interphase, the cells are actively involved in protein synthesis. One protein synthesised by human cells is CFTR. This 1480 amino acids long protein is encoded by a 189000 nucleotide gene on chromosome 7.

8.3 Which biomolecules make up a chromosome?

_____

[one mark]

8.4 What is the minimum number of nucleotides required to encode for the 1480 amino acid protein?

_____

_____

[two marks]

8.5 Why is the gene much longer than the minimum number of nucleotides required to produce the protein?

_____

_____

_____

[two marks]

8.6 Give ONE function for each of the following terms as used during protein synthesis.

Terms	**Function during protein synthesis**
Promoter site	
RNA polymerase	
Stop codon	

[three marks]
[Total: thirteen marks]

9. Isolation is an important mechanism for speciation. State, giving reasons, whether the following situations are a consequence of pre-zygotic or post-zygotic isolating mechanisms.

9.1 The Maltese Wall Lizard living on the island of Filfla is a different subspecies from that living on the island of Malta.

[two marks]

9.2 Adhesive proteins on the surface of the sperm and complementary receptors on the egg cells of sea urchins are species specific.

[two marks]

9.3 The cross between a female horse and a male donkey results in a sterile offspring.

[two marks]

9.4 The Red-legged Frog and Yellow-legged Frog are two similar species that have overlapping niches, however the former mates in winter while the latter mates in spring.

[two marks]

[Total: eight marks]

10. Briefly explain the following statements related to population ecology.

10.1 An increase in population size may result in an increase in the mortality rate.

[three marks]

10.2 Fluctuations in the population size of the Canada lynx (predator) are tightly linked to the fluctuations in the snowshoe hare (prey) population.

[three marks]

10.3 The distribution of the barnacle Chthamalus fragilis along the intertidal zone is narrowed when it coexists with the barnacle Semibalanus balanoides.

[three marks]
[**Total: nine marks]**

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MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

UNIVERSITY OF MALTA, MSIDA

MATRICULATION EXAMINATION
ADVANCED LEVEL
MAY 2014

SUBJECT:	BIOLOGY
PAPER NUMBER:	II
DATE:	15th May 2014
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.

Captured: the moment photosynthesis changed the world

Billions of years ago, a time when the Earth's atmosphere was anoxic (lacked oxygen gas), a microorganism similar to a present-day cyanobacterium split a water molecule. This microorganism had just perfected photosynthesis, a process that freed oxygen from water molecules. With this type of photosynthesis came an atmosphere dominated by oxygen. "This was the biggest change that ever occurred in the biosphere," says Kevin Redding from the Arizona State University. The extinction caused by oxygen was probably the largest ever seen, possibly killing most of Earth's anaerobic inhabitants but at the same time creating an opportunity for the evolution of life we know today.

Photosynthesis uses light and a source of electrons to generate energy. In most modern photosynthetic organisms, that source of electrons is water, with oxygen being the waste product. However, there are no signs that oxygen was being formed when photosynthesis first appeared around 3.4 billion years ago. This means that early photosynthesisers probably took electrons by splitting other molecules such as hydrogen sulphide instead of water. This changed about 2.4 billion years ago. Rocks formed at the time contained oxidized minerals, showing that oxygen gas began to accumulate in the atmosphere.

To help work out how this happened, Woodward Fischer's team from the California Institute of Technology studied South African rocks that formed before 2.4 billion year ago. Their analysis shows that although the rocks were formed in anoxic conditions, all of the manganese in the rocks was found in an oxidised form. In the absence of atmospheric oxygen, manganese needs some sort of catalyst to help it oxidise. According to Fischer's team, the best explanation is that a photosynthetic organism was using electrons from manganese, leaving behind the oxidised form of manganese.

Scientists believe that oxygen producing photosynthesis began when early cyanobacteria by chance floated into a watery environment rich in manganese, and quickly adapted to take advantage of the new source of electrons. Later, because manganese is a relatively scarce resource that cannot be tapped indefinitely, the cyanobacteria evolved a different strategy. They incorporated manganese directly into their photosynthetic structures and used it as a rechargeable battery: draining it of its electrons, but allowing its supplies to be replenished by gaining electrons from another, more plentiful source - water. A close look at today's plants and algae shows that manganese oxidation is still a vital part of photosynthesis, as modern photosynthetic structures from photosystem II require manganese.

Adapted from New Scientist Magazine issue 2894.

1.1. In which Kingdom are cyanobacteria classified? Give THREE unique structural features of the named Kingdom.

[two marks]

1.2 Give TWO possible biological explanations to why photosynthesis (line 4) caused one of the largest extinctions.

[two marks]

1.3 Give ONE reason why 'life we know today' (line 7) would not have been possible without the evolution of oxygen producing photosynthesis.

[two marks]

1.4 What was the function of manganese in the first photosynthetic microorganisms?

[one mark]

1.5 List THREE types of photosynthesis that are mentioned in the extract to show how photosynthesis evolved with time.

[three marks]

1.6 Name the currently withheld theory of how photosynthetic eukaryotes evolved from cyanobacteria. State THREE pieces of evidence that support this theory.

[four marks]

1.7 Briefly outline how photosystem II (line 28) in eukaryotic organisms utilizes light energy to generate electrons.

[three marks]

1.8 In eukaryotes, the electrons generated from water via photosystem II are then used to synthesise ATP and NADPH + H^+. Explain the processes involved in the production of these two molecules during non-cyclic photophosphorylation.

[six marks]

1.9 The accumulation of oxygen in the atmosphere has led to the formation of the ozone layer in the upper atmosphere. Explain why, nowadays this layer has become a major environmental concern.

[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. The human immune system has evolved a number of defence mechanisms for protection against pathogens. Discuss this statement using specific mechanisms as examples.

3. Give a comparative account of the circulatory systems found in insects, fish and mammals.

4. Write an account on supporting tissue in plants.

5. Compare and contrast asexual and sexual reproduction.

[Total: fifty marks]

SECTION C

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

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

6.1 Mitochondria are a prominent feature of spermatozoa.
6.2 The Fallopian tubes have ciliated epithelium.
6.3 The alveoli of the lungs are covered by squamous epithelium.
6.4 The Haversian system (osteon) is composed of concentric structures.
6.5 Cnidocytes are characteristic of Cnidaria.

[five marks each]

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

7.1. Productivity of an ecosystem is measured in units of energy rather than units of biomass.
7.2. The number of trophic levels in a food chain rarely exceeds four or five.
7.3. The garigue is one of the most species diverse habitats in the Maltese Islands.
7.4. Since its introduction in the 1800s, the Cape Sorrel (*Oxalis pes-caprae*), has outcompeted a number of local plants.
7.5. The reduction of a population size below a certain limit is of a major concern to wildlife biologists.

[five marks each]
[Total: twenty five marks]

Index No.:_____ **AM 05/III.14m**

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

UNIVERSITY OF MALTA, MSIDA

MATRICULATION EXAMINATION
ADVANCED LEVEL
May 2014

SUBJECT:	BIOLOGY
PAPER NUMBER:	III
DATE:	21st May 2014
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.*
- *The use of electronic calculators is permitted.*

For examiners' use only:

Question	1	2	3	**Total**
Score				
Maximum	21	16	13	**50**

1. A recently reconstructed house courtyard was designed with a rock waterfall and a pond. *Dryopteris* (Figure 1), was then planted around the pond. A year after its construction, a small pioneer community was established and the courtyard was buzzing with life. Three main observations that were noted after one year are listed below.

   Observation A: The rocks wetted by the passage of water were covered by algal protoctists.
   Observation B: The porous rocks around the pond were colonised by *Funaria* (Figure 2).
   Observation C: *Sonchus* (Figure 3), grew in small soil pockets away from the pond.

   Figures 1 to 3 show the three main plant species present in the courtyard after a year.

Figure 1
Magnification x0.3
(http://caliban.mpiz-koeln.mpg.de/)

Figure 2
Magnification x10
(http://www.anbg.gov.au/)

Figure 3
Magnification x1
(http://www.washingtonpost.com/)

1.1 Figures 1 and 3 show two plant species. Name a major taxonomic group within which each respective organism is classified. Give TWO morphological features which are diagnostic to the mentioned taxonomic group.

Organism	Major taxonomic group	TWO morphological diagnostic features for each organism
Dryopteris **Figure 1**		1. 2.
Sonchus **Figure 3**		1. 2.

[three marks]

1.2 Was the choice of planting *Dryopteris* suitable for the habitat present? Explain your answer.

[one mark]

1.3 Illustrate your answer to Question 1.2 by explaining the different stages of the life cycle of *Dryopteris*.

[five marks]

1.4 Give scientific explanations for Observations A, B and C.

A:

B:

C:

[six marks]

1.5 Why can the plant community present after one year be referred to as being a 'pioneer community'?

_____

_____

[one mark]

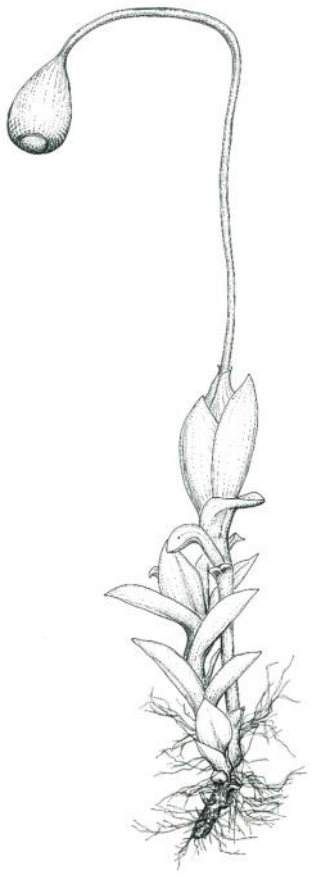
1.6 Suggest how *Funaria* and *Sonchus* could have colonised the courtyard.

_____

_____

[two mark]

1.7 Label the figure below (copy of Figure 2) to show the various structures visible in *Funaria.*



[three marks]
[Total: twenty-one marks]

2. The budgerigar is a small parrot native to Australia. This species is nowadays commonly bred for its colourful feathers which can either be blue, green, yellow or white. Two autosomal unlinked genes, **A**/**a** and **B**/**b**, are involved in the inheritance of feather colour in budgerigars

Genetic studies of these birds have shown that:
a bird which has at least one dominant allele **A** but is homozygous for **b** has yellow feathers;
a bird which has at least one dominant allele **B** but is homozygous for **a** has blue feathers;
a bird with at least one dominant allele **A** and one dominant allele **B** has green feathers;
a bird that is homozygous for **a** and **b** has white feathers.

2.1 Define the following terms:

autosomal unlinked genes;

[one mark]

dominant allele;

[one mark]

homozygous.

[one mark]

A yellow male budgerigar and a blue female budgerigar of unknown genotype were donated to an animal park. The person taking care of these budgerigars noticed that all the offspring were green-feathered budgerigars.

2.2 Identify the genotype of the parent budgerigars (any relevant working should be included).

[four marks]

2.3 Two green-feathered budgerigars that were heterozygous for both genes were crossed. The resulting offspring had a variety of colours. What is the phenotypic ratio of the offspring from this cross? (any relevant working should be included)

[three marks]

To study a population of wild budgerigars in an Australian woodland, a researcher collected 15 specimens living on a single tree and analysed their genotype for feather colouration. During his study he noted that the allele frequencies were not in agreement with the expected values from the Hardy-Weinberg equilibrium.

2.4 Which statistical test did the researcher use to determine whether the population was in agreement with the Hardy-Weinberg equilibrium or not?

[one mark]

2.5 Mention TWO biological processes that could have led to a deviation from the Hardy-Weinberg equilibrium.

[two marks]

2.6 Another scientist said that even though the research shows a deviation from the Hardy-Weinberg equilibrium, yet one has to be cautious when interpreting the data collected by the first researcher. Mention TWO limitations in the study that have led the second scientist to make such statement.

[two marks]

2.7 Suggest how the first scientist could improve his methodology when analysing the budgerigars population in the studied Australian woodland.

[one mark]
[Total: sixteen marks]

3. Figure 4 is a photomicrograph of a section through a pig's liver, stained with Hematoxylin and Eosin, as observed through a light microscope (magnification x40).

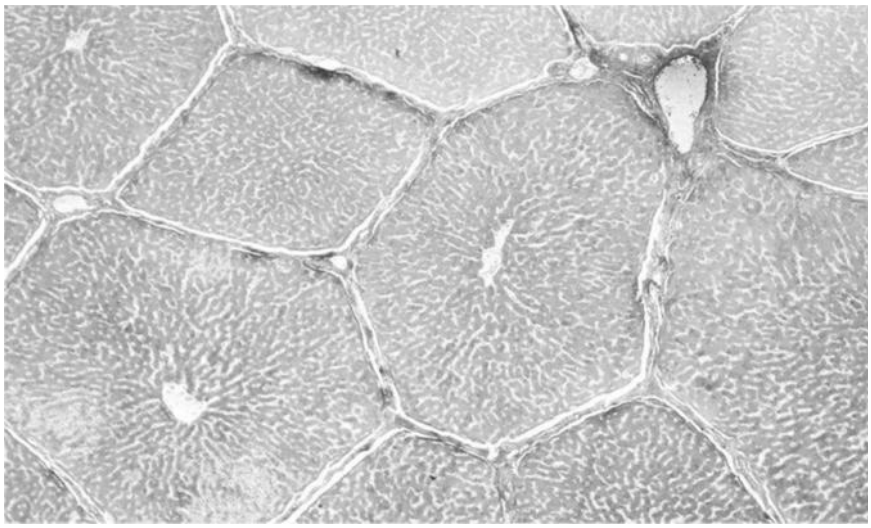


Figure 4

(http://calphotos.berkeley.edu/)

3.1 Draw an annotated diagram of a liver lobule shown in Figure 4. Use the space provided in the box below for your drawing.

[eight marks]

Please turn the page.

3.2 Briefly explain why tissue samples are stained prior to microscopic observation.

[one mark]

3.3 Describe the steps involved in estimating the diameter of a liver lobule using the light microscope.

[four marks]
[Total: thirteen marks]

Index No.:_____ **AM 05/IV.14m**

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

UNIVERSITY OF MALTA, MSIDA

MATRICULATION EXAMINATION
ADVANCED LEVEL
May 2014

SUBJECT:	BIOLOGY
PAPER NUMBER:	IV (practical)
DATE:	6th June 2014
TIME:	1 hr 30 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**

1. Vitamin C is an essential nutrient in the human diet. Fruit is a good source of vitamin C, but this vitamin breaks down during food processing and its concentration is dependent on various factors, including temperature.

   For this experiment you are provided with four samples of orange juice. These four samples were prepared by first extracting the orange juice from a batch of fresh oranges. Then the juice extract was stirred for a few minutes and was divided into four identical containers. Each container was processed under different conditions as indicated in Figure 1.

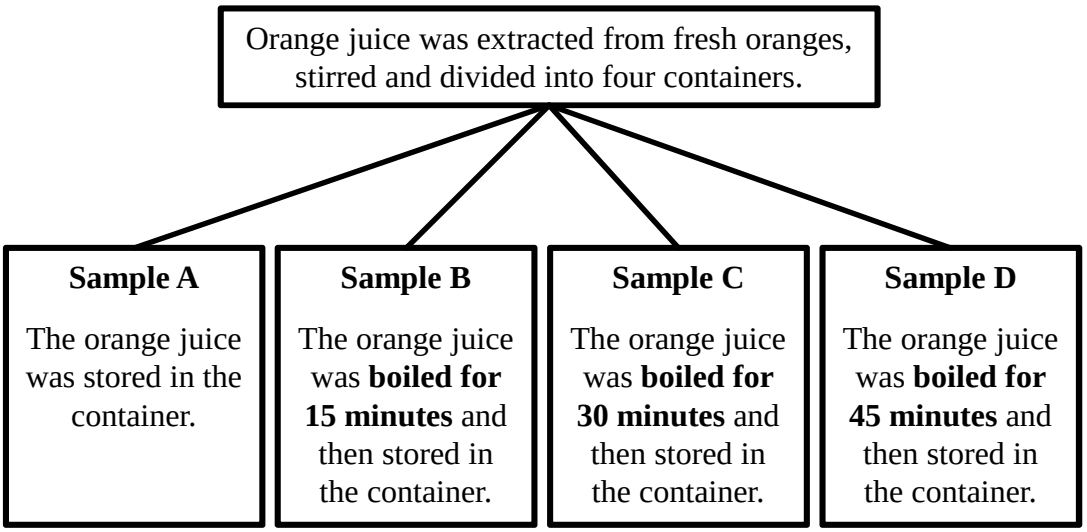


Figure 1

You are required to devise and implement an experiment that would enable you to compare the amount of vitamin C in each of the four orange juice samples provided.

You are provided with the following:

- Four samples of orange juice (A to D), which are already processed as indicated in Figure 1
- Starch-iodine indicator (labelled as indicator)
  This indicator has a blue-black colour which is decolourized in the presence of vitamin C
- Distilled water
- Test tubes
- Plastic dropping pipette
- Other laboratory apparatus as required

Candidates are advised to use 2 millilitres of the orange juice samples during this experiment.

1.1 Suggest a suitable null hypothesis for this experiment.

_____

_____

[two marks]

1.2 Why was the orange juice extract stirred before it was divided into the four containers?

[two marks]

1.3 Using the equipment provided, devise and describe an experimental procedure that may be used to compare the amount of vitamin C in each of the four orange juice samples provided (labelled Samples A to D).

[eleven marks]

Carry out the investigation that you devised in Question 1.3 and record the results in Question 1.4.

1.4 Record your results in the space provided below. *Marks will be awarded for the structure and the organisation of the results obtained.*

[six marks]

1.5 Mention and justify ONE precaution taken during the experiment.

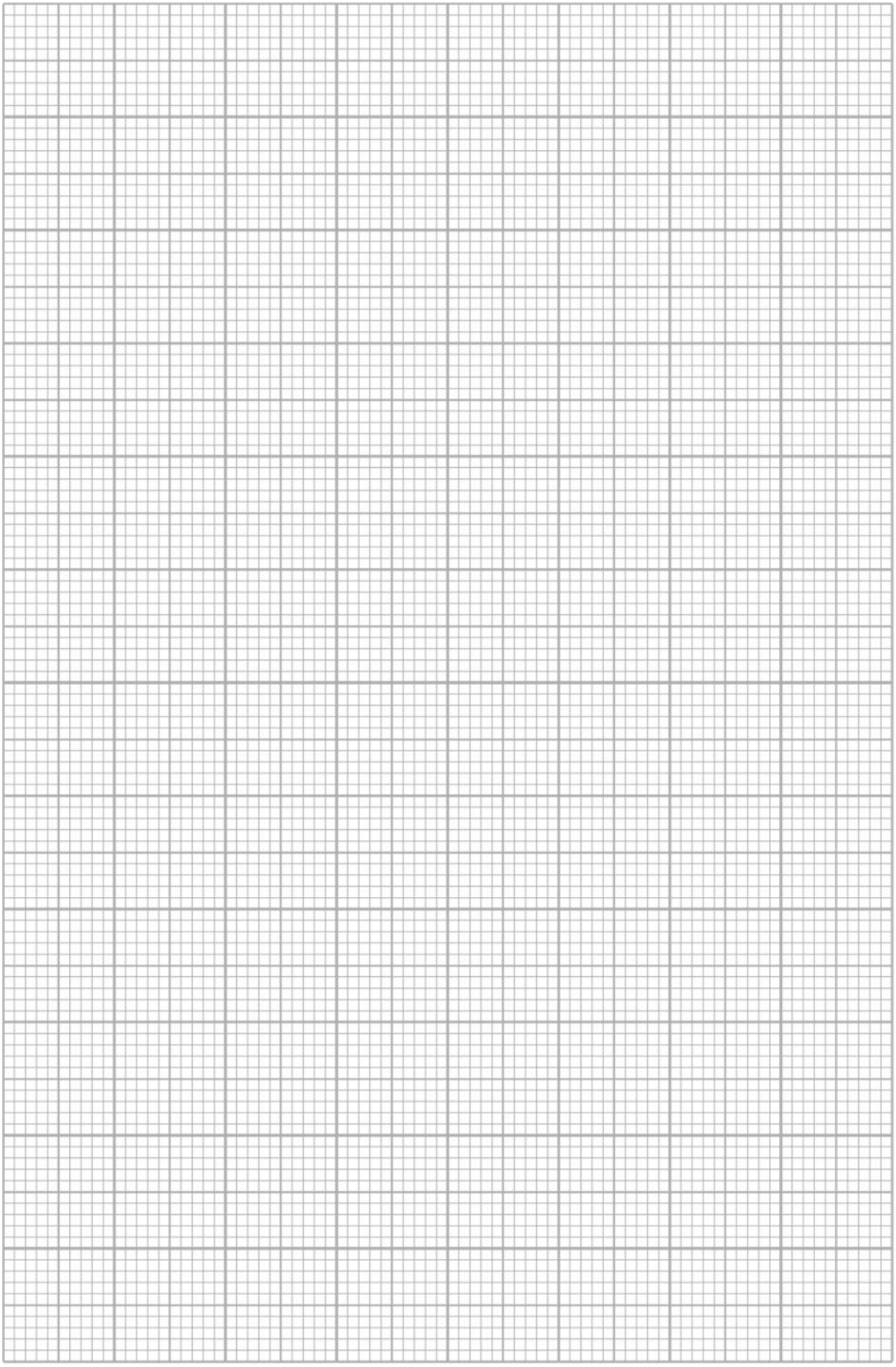
_____

_____

[two marks]

1.6 Draw a graph to represent the effect of boiling on the vitamin C content in orange juice as recorded in your results. *Use the graph paper provided on page 5 of this booklet.*

[six marks]



1.7 What conclusions can be drawn from your results?

[three marks]

1.8 How do your conclusions (Question 1.7) link to the dietary requirements of humans?

[two marks]

1.9 Describe ONE way in which the experimental procedure could be modified to produce results that are more reliable.

[two marks]

1.10 List TWO sources of error and explain how they might have influenced your results.

[four marks]

[Total: forty marks]

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