

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD
UNIVERSITY OF MALTA, MSIDA
MATRICULATION EXAMINATION
ADVANCED LEVEL
SEPTEMBER 2015

SUBJECT: BIOLOGY
PAPER NUMBER: I
DATE: 1st September 2015
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	11	Total
Score												
Maximum	8	8	11	6	10	12	8	10	10	7	10	100

DO NOT WRITE ABOVE THIS LINE

1. This question is about DNA.

1.1. List TWO purine nitrogenous bases found in DNA.

[two marks]

1.2. Fill in the table below to identify the role of enzymes in DNA replication.

Enzyme	Function
Helicase	
Ligase	

[two marks]

1.3. What are Okazaki fragments?

[two marks]

1.4. Why is DNA replication considered to be semi-conservative?

[two marks]

[Total: Eight marks]

DO NOT WRITE ABOVE THIS LINE

2. This question is about transpiration.

2.1. Explain what is meant by the term *transpiration*.

[one mark]

2.2. Explain, using your knowledge of the transpiration-cohesion-tension theory, how water moves up the stem from the roots through the xylem.

[four marks]

Figure 1 shows the volumes of water absorbed by the plants and the volume of water lost by transpiration measured over periods of 4 hours during one day.

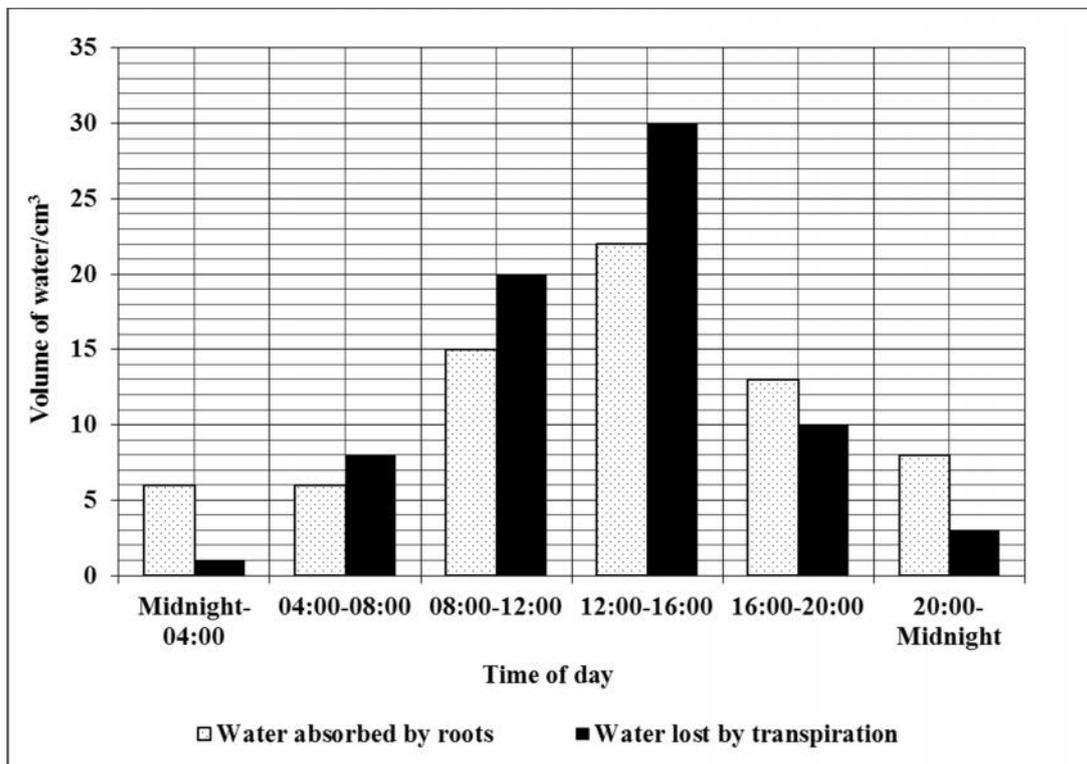


Figure 1: Measure of water absorbed and water lost in plants

DO NOT WRITE ABOVE THIS LINE

2.3. Describe what is happening to the volume of water absorbed and that transpired between midnight and 16:00 (**Figure 1**).

[one mark]

2.4. Explain these changes in the volumes.

[two marks]
[Total: Eight marks]

3. This question is about thermoregulation.

3.1. Define the term *thermoregulation*.

[one mark]

3.2. Distinguish between ectotherms and endotherms.

[two marks]

3.3. Give TWO advantages of endothermy over ectothermy.

[two marks]

DO NOT WRITE ABOVE THIS LINE

3.4. What behavioural mechanisms of temperature regulation would you expect a lizard in the desert to exhibit early in the morning and around midday?

[two marks]

3.5. Explain why elephants flap their highly vascularised large ears.

[one mark]

3.6. What do you understand by *countercurrent heat exchanger*?

[three marks]

[Total: Eleven marks]

4. This question is about stimuli in plants.

4.1. Define the term *phototropism*.

[one mark]

DO NOT WRITE ABOVE THIS LINE

A group of biology students carried out an investigation about stimuli response in plants. They have grown short shoots from seeds. For this investigation, the students used black plastic to cover parts of some of the shoots and exposed the shoots to unidirectional light. Furthermore, they put boxes over the shoots to keep out surrounding light. **Figure 2** shows how the investigation was set up.

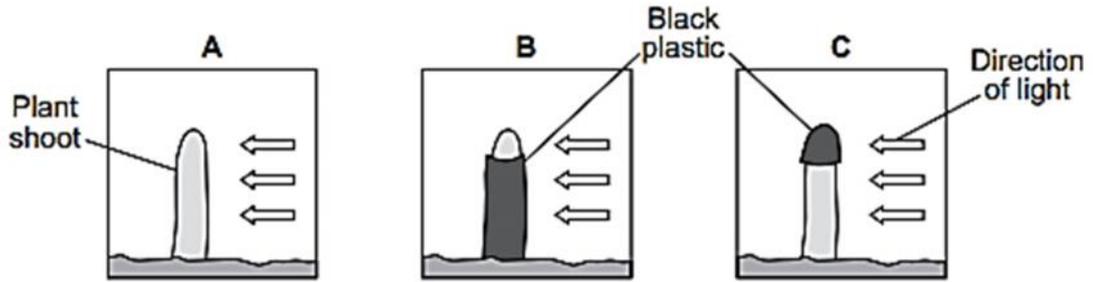


Figure 2: Plant Stimuli Investigation

Figure 3 shows the growth of the shoots after two days.

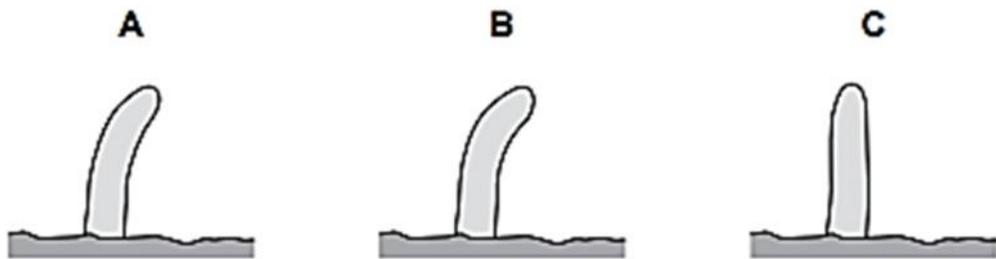


Figure 3: Results after two days

4.2. Explain why shoots A and B grew towards the light while C did not.

[three marks]

DO NOT WRITE ABOVE THIS LINE

4.3. Describe the mechanism by which auxin affects cell elongation

[two marks]
[Total: Six marks]

5. This question is about genetics.

Huntington’s disease is a genetic disorder caused by an autosomal dominant allele. At fertilization, if both gametes carry the mutant allele, the resultant embryo will not develop. The homozygous genotype is known to be *lethal*.

5.1. State what is meant by *an autosomal dominant allele*.

[one mark]

5.2. If both parents begin to show symptoms of the disease, calculate the probability of their child developing Huntington’s disease in adulthood.

Probability: _____ %
[five marks]

DO NOT WRITE ABOVE THIS LINE

5.3. Red-green colour blindness is a sex-linked recessive condition, while yellow-blue colour blindness is an autosomal recessive condition.

Complete the following statements by writing whether the statements apply for yellow-blue colour blindness, red-green colour blindness or both types of colour blindness.

5.3.i. Males are more likely to be _____ colour blind than females.

5.3.ii. Colour blind fathers can pass on the _____ condition to their sons.

[four marks]

[Total: Ten marks]

6. This question is about nutrition and ecological relationships.

6.1. Complete the following table by filling in the blank spaces.

Term	Description
Commensalism	
	If two species, with the same niche, coexist in the same ecosystem, then one will be excluded from the community due to intense competition.
	An association between organisms of two different species in which one is inhibited whilst the other species is unaffected.
Mutualism	

[six marks]

6.2. Give TWO differences between the dentitions of herbivores and carnivores.

[two marks]

Question 6.3 refers to **Figure 4** which shows the skull of a mammal.



Figure 4

6.3.i. Identify whether the mammal is a herbivore or carnivore.

_____ **[one mark]**

6.3.ii. Give its dental formula.

_____ **[one mark]**

6. 4. Describe an adaptation, other than dentition, which ruminant mammals adopt in order to have efficient digestion.

[two marks]
[Total: Twelve marks]

7. This question is about plant reproduction.

State whether the statements below are true or false by circling your answer. If false, re-write the statement correctly.

7.1. In the life cycle of a plant, spores are produced by the gametophyte.

TRUE/FALSE _____

[two marks]

DO NOT WRITE ABOVE THIS LINE

7.2. One sperm fuses with the tube cell to form the embryo, and a second sperm fuses with a generative cell to form the endosperm.

TRUE/FALSE _____

[two marks]

7.3. Bryophytes undergo alternation of generations with the sporophyte stage being dominant.

TRUE/FALSE _____

[two marks]

7.4. The function of the cotyledons in most dicot seeds is to protect the embryo from harmful substances found in the soil.

TRUE/FALSE _____

[two marks]
[Total: Eight marks]

8. This question is about the immune system.

Phagocytes form part of the body's non-specific response to disease.

8.1. Why is the response involving phagocytes regarded as non-specific?

[one mark]

8.2. Why are phagocytes described as a secondary defence against pathogens?

[one mark]

8.3. Phagocytes are able to pass from the blood into the tissue fluid. Explain how phagocytes are adapted for this purpose.

[two marks]

8.4. Complete the following passage.

The body can achieve immunity in a variety of ways. When _____ are introduced directly into the body, it is known as passive immunity. This can happen through breast milk or through the placenta. This is a type of _____ immunity which provides protection until the immune system is fully developed.

It is very important that immediate protection is provided in case of infection by a bacterium through a wound, such as tetanus bacteria. In this case, suitable blood serum from another individual is injected into the bloodstream to provide _____ immunity.

Edward Jenner was one of the first to successfully produce a technique of stimulating the immune system into action so that the body develops immunity without developing the symptoms of the disease. Nowadays, a harmless form of the _____ is injected so that the body develops antibodies and _____ cells for future defence. This is known as _____.

[six marks]

[Total: Ten marks]

9. This question is about gaseous exchange in mammals.

9.1. Describe THREE adaptations present in the respiratory surface which maximize gaseous exchange.

[six marks]

Oxygen is transported around the body by haemoglobin which is found in erythrocytes. People who have a low level of this pigment or have a low number of red blood cells suffer from anaemia.

9.2. Describe the structure of a haemoglobin molecule.

[two marks]

DO NOT WRITE ABOVE THIS LINE

9.3. A pathology technician carried out blood tests on samples from a patient with anaemia and a healthy person. The results are presented in the table below:

	Mass of haemoglobin per 100 cm ³ of blood (g)	Volume of O ₂ per gram of haemoglobin (cm ³)	Volume of O ₂ per 100 cm ³ of blood (cm ³)
Patient with anaemia	1.34		16.10
Healthy person	1.34	15.00	20.10

Use the information in table above, to find the volume of oxygen per gram of haemoglobin in the patient with anaemia. Show your working.

Answer: _____
[two marks]
[Total: Ten marks]

10. This question concerns skeletal muscles in the human body.

10.1. Give a brief description of the **gross structure** of skeletal muscle.

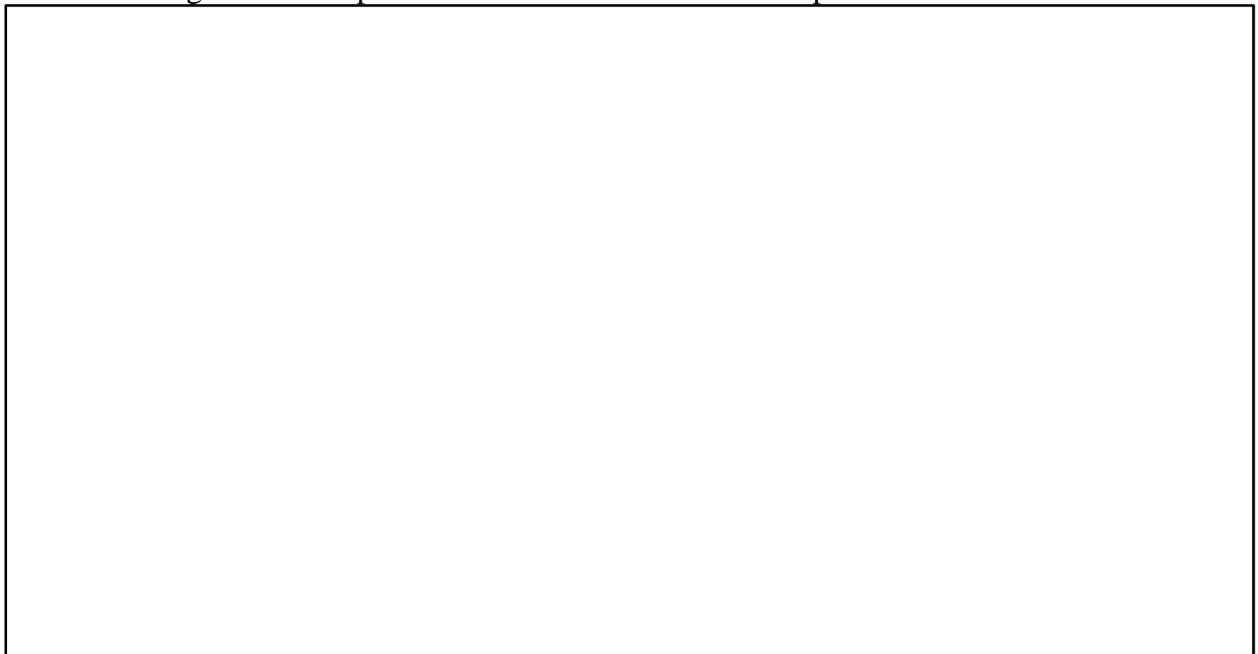
[two marks]

DO NOT WRITE ABOVE THIS LINE

10.2. Indicate why skeletal muscle is striated.

[two marks]

10.3. Draw a diagrammatic representation of a sarcomere in the space below.



[three marks]

[Total: Seven marks]

11. This question is about local ecology.

11.1. List **THREE** habitat types that are found in the Maltese Islands.

[three marks]

DO NOT WRITE ABOVE THIS LINE

11.2. “Buskett was originally planted by man but is now self-regenerated and has the natural characteristics of a climax community and may be described as a semi-natural woodland” (Schembri, 1993). What is a climax community?

[two marks]

11.3. Which type of vegetation characterises a garigue?

[two marks]

11.4. List TWO species of plants that you would expect to find in a garigue. (*Both scientific and common names are accepted.*)

[two marks]

11.5. In which type of Maltese habitat would you expect to find shrubs like *Olea europaea* (olive tree), *Ceratonia siliqua* (carob tree) and *Pistacia lentiscus* (lentisk)?

[one mark]
[Total: Ten marks]

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MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD
UNIVERSITY OF MALTA, MSIDA
MATRICULATION EXAMINATION
ADVANCED LEVEL
SEPTEMBER 2015

SUBJECT:	BIOLOGY
PAPER NUMBER:	II
DATE:	2 nd September 2015
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. 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.

Mongoose inbreeding maintains social system?

The human efforts at incest are thankfully rare nowadays, but at least three other mammalian species manage to produce viable populations with very close inbreeding systems. The genetic disadvantage of inbreeding depression in the banded mongoose (*Mungos mungo*) is countered by survival gains in remaining with the social group.

- 5 Newly formed mongoose groups have a mortality rate three times higher than that of established ones, and mongooses that encroach on neighbouring groups are often met with violence. But breeding between close relatives un.masks harmful recessive alleles. Even females in this species mate with strangers when the frequent group fights give them a chance to copulate, very briefly! In theory the inbreeding would (1) increase inclusive fitness, and (2) increase cooperative benefits. A large genetic dataset was therefore prepared for *Mungos mungo* groups with a mean number size of 18.

- 15 With all females allowed to breed, the animals remain in their natal groups throughout. Pups are reared communally so that mating after adolescence is often with familiar individuals, though siblings may not be recognised. If a new group forms, a cohort of females from a group meet with a cohort of males from another. Older groups with small numbers would have high levels of inbreeding.

- 20 microsatellite markers marked out parentage for some group members while the frequency of female breeding in the group was noted in the 14 groups found in Uganda's Queen Elizabeth National Park. The results were analysed for 516 pups, 64% of which had been born to females that used resident males as fathers. 18% were born to females mated with extra-group males and 18% were born to females that had dispersed from the group. Most of the latter pups were fathered by the resident males (i.e. 77 out of 95 pups.) As a group aged, relatedness of parent pairs increased significantly, but smaller groups did not follow that expected pattern.

- 25 27% of offspring were conceived by mothers that bred within their natal group and were related to their mates by a coefficient of relationship of 0.25 or higher—the equivalent genetic similarity between half siblings or a grandparent/grandchild. Additionally, 7.5% of pups were conceived by parents related by 0.5 or more—full siblings or a parent/child. Father/daughter incest occurred eight times during the study, but interestingly, mother/son breeding was not observed—perhaps due to the fact that males take longer to reach sexual maturity and their mothers are dead by the time they're ready to mate.

Adapted from: Schultz, David (2014). *Science*.

URL: <http://news.sciencemag.org/biology/2014/12/pros-incest-outweigh-cons-mongooses> and
Armstrong, Dave (2014). *Earth Times*.

URL: <http://www.earthtimes.org/nature/mongoose-inbreeding-social/2784/>

- 1.1. What phylum and class does the mongoose belong to? **[two marks]**
- 1.2. Give THREE characteristics of this class. **[three marks]**
- 1.3. What is genetic diversity? **[two marks]**
- 1.4. What do you understand by the term *population*? (line 2) **[two marks]**
- 1.5. Define *mortality*. (line 5) **[two marks]**
- 1.6. Why is inbreeding normally considered to be disadvantageous to a population? **[two marks]**
- 1.7. “*Microsatellite markers marked out parentage for some group members.*” (line 17) Give another technique that is used to identify parentages. **[one mark]**
- 1.8. Apart from identifying parentages, give TWO reasons why genetic datasets are useful. **[two marks]**
- 1.9. “*If a new group forms, a cohort of females from a group meet with a cohort of males from another.*” (lines 14-15) What is the biological term given to the fact that the females leave their native group? **[one mark]**
- 1.10. Give THREE reasons why the Hardy-Weinberg equilibrium will not be valid in the mongoose populations even when there is no gene flow between the populations. **[three marks]**
- 1.11. From the text, explain why breeding between mother and son is not observed. **[two marks]**
- 1.12. According to the text, why is inbreeding selected for in the banded mongoose? **[three 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 pituitary gland is a “master gland” in the human body. Discuss.
3. Give an overview of photosynthesis in plants.
4. The key to speciation is the evolution of genetic differences between the incipient species. Describe the sources of genetic variation and discuss the mechanisms that can lead a group of organisms to become separate species.
5. Describe the process involved in the genetic engineering of products such as vaccines, and give examples of recombinant DNA technology applications in the medical and pharmaceutical industry. Mention the advantages and/or disadvantages of these applications and comment on any ethical implications, where applicable.

[Total: Fifty marks]

SECTION C

Answer **ONE** question from this section.

6. **Write brief notes on each of the following:**
 - 6.1. the cleidoic egg;
 - 6.2. the placenta;
 - 6.3. radial symmetry in animals;
 - 6.4. multiple alleles as exemplified by the ABO blood group system;
 - 6.5. the S-model of population growth.

[five marks each]

7. **Use your knowledge of Biology to explain the following statements:**
 - 7.1. Some plants found in the desert open their stomata at night.
 - 7.2. Viruses are not included in the Five-Kingdom classification scheme.
 - 7.3. Foetal haemoglobin has an oxygen dissociation curve to the left of the maternal haemoglobin.
 - 7.4. Crossing two pink-flowered snapdragons together is not a 100% certain method of obtaining pink flowers in the next generation of plants.
 - 7.5. During a second pregnancy, a rhesus-negative mother is given suppressant drugs.

[five marks each]

[Total: Twenty-five marks]

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

UNIVERSITY OF MALTA, MSIDA

MATRICULATION EXAMINATION
ADVANCED LEVEL
SEPTEMBER 2015

SUBJECT:	BIOLOGY
PAPER NUMBER:	III
DATE:	3 rd September 2015
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	19	13	18	50

DO NOT WRITE ABOVE THIS LINE

1.2. **Figure 1** shows the full cycle of meiosis (first and second meiotic divisions), as seen in the anther of *Lilium* sp. when observed under the microscope. Micrographs A to J represent the different stages of meiosis in a non-chronological order. Identify meiosis stages A to J.

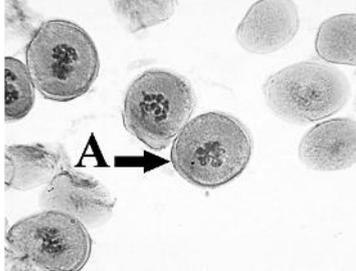
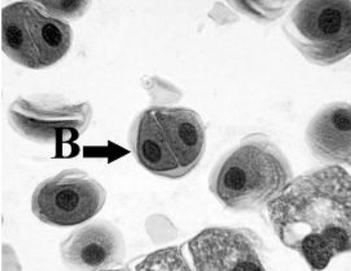
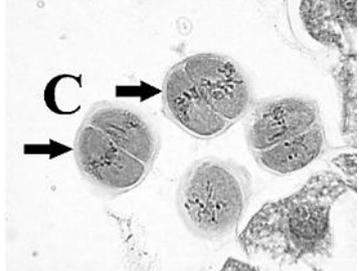
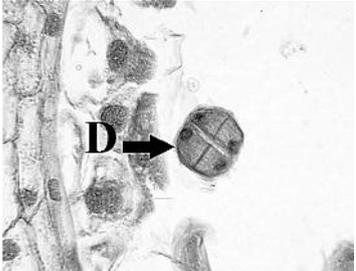
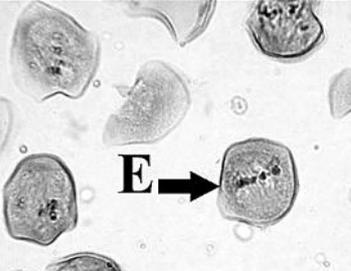
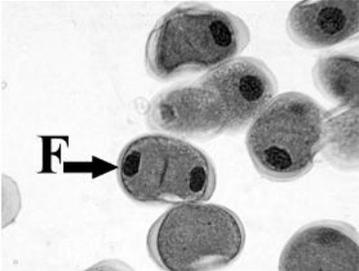
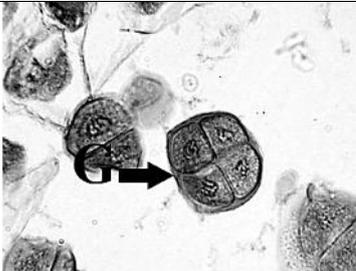
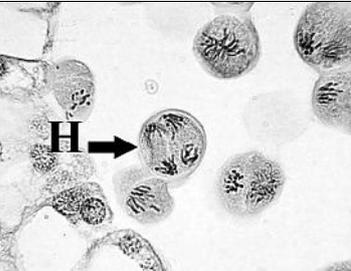
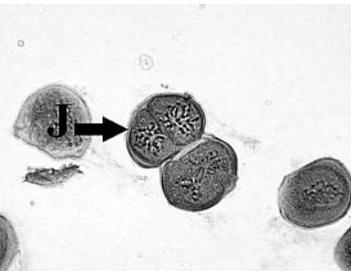
		
<p>A:</p>	<p>B:</p>	<p>C:</p>
		
<p>D:</p>	<p>E:</p>	<p>F:</p>
		
<p>G:</p>	<p>H:</p>	<p>I:</p>
		
<p>J:</p>		

Figure 1: Meiosis in *Lilium* sp. Anther

Images Source: <http://www.usca.edu/biogeozelmer/122/celldivision/meiosis/>

[five marks]

1.3. **Figure 2** shows two types of animal epithelial tissue as seen under the microscope.

1.3.i. Identify the two epithelial cells labelled I and II.

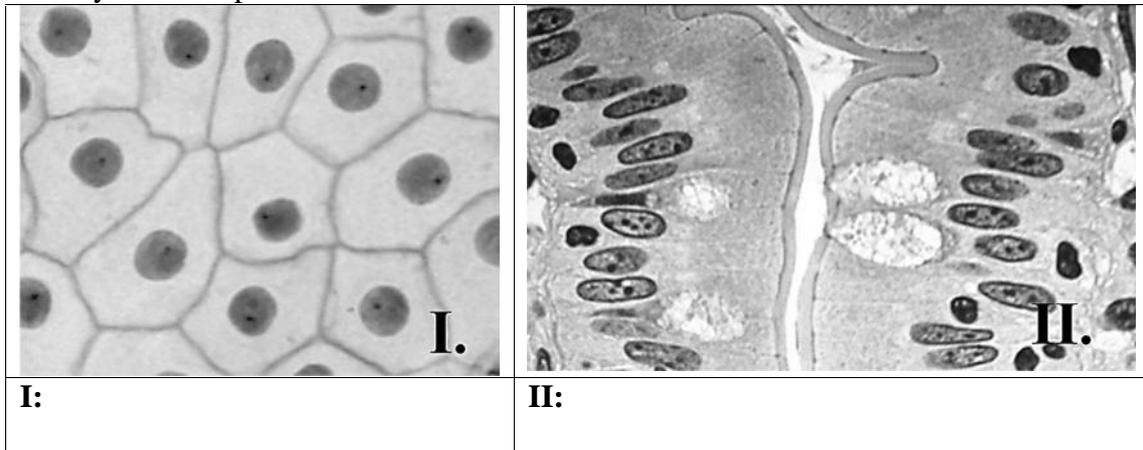
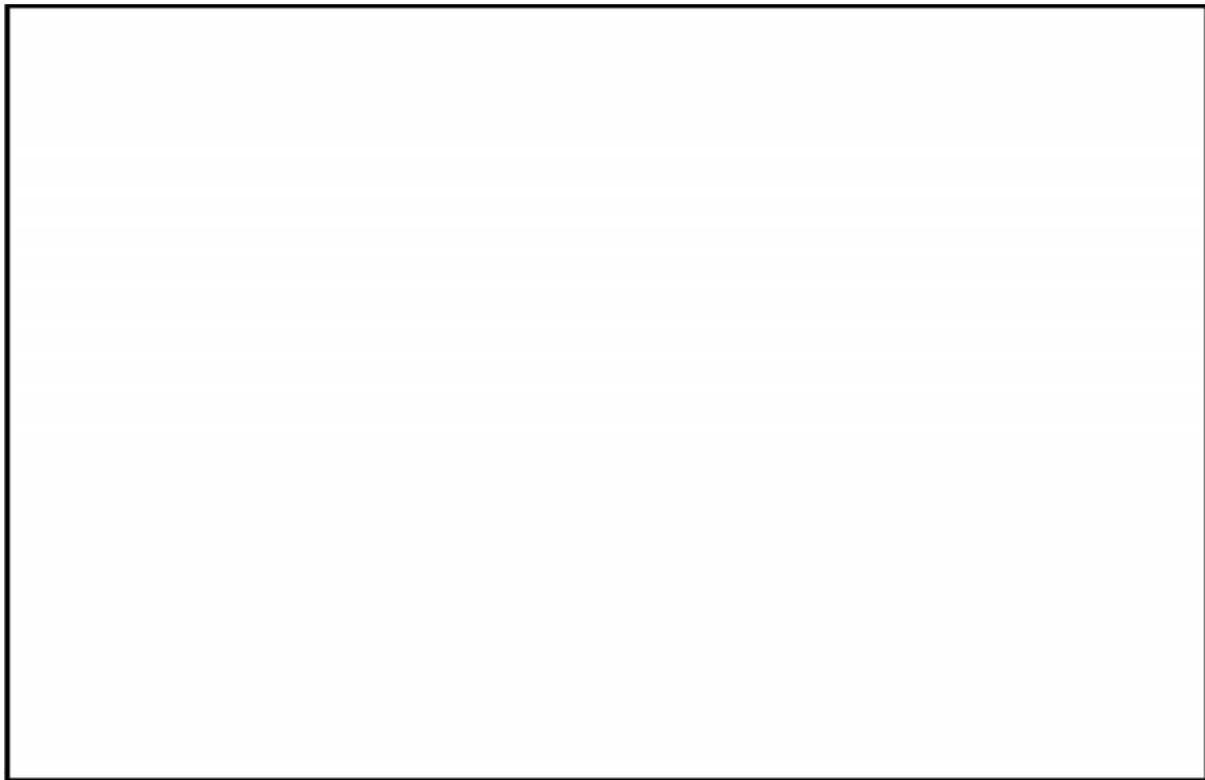


Figure 2: Epithelial Cells

[two marks]

1.3.ii. Epithelial Cell Type II is found in the small intestine. Draw and label a few cells from this epithelial type as shown in microphotograph II (**Figure 2**).



[four marks]

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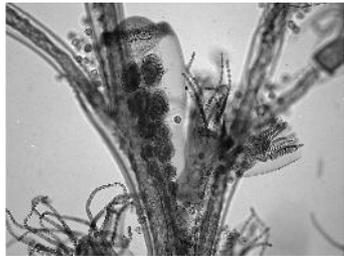
1.3.iii. Choose TWO labelled features from your drawing in *Question 1.3.ii* and describe their relation to the function of these cells.

[two marks]
[Total: Nineteen marks]

Please turn the page.

DO NOT WRITE ABOVE THIS LINE

2.1. Identify the phylum and class for the organisms shown in **Figures 3, 4, 5** and **6** and give ONE visible characteristic feature for each organism.

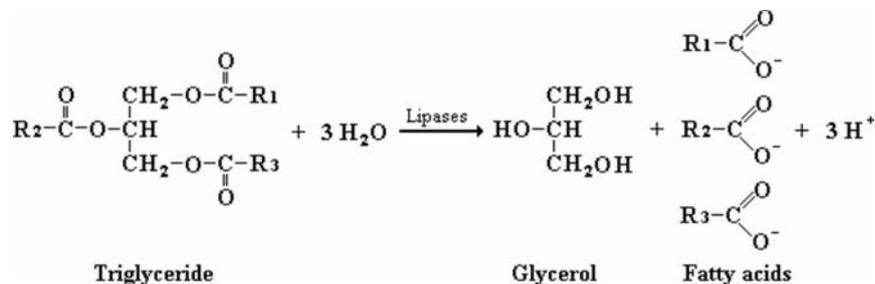
 <p>Figure 3</p>	<p>Phylum:</p> <p>Class:</p>	<p>Characteristic Feature:</p>
 <p>Figure 4</p>	<p>Phylum:</p> <p>Class:</p>	<p>Characteristic Feature:</p>
 <p>Figure 5</p>	<p>Phylum:</p> <p>Class:</p>	<p>Characteristic Feature:</p>
 <p>Figure 6</p>	<p>Phylum:</p> <p>Class:</p>	<p>Characteristic Feature:</p>

[six marks]

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3. An experiment was carried out to determine the effect of substrate concentration on the rate of fat hydrolysis by the enzyme *lipase*.

Lipase breaks down fats into glycerol and fatty acids, and the liberation of fatty acids lowers the pH of the solution.



Different milk concentrations were prepared, and phenolphthalein indicator was used to mark the end point of the hydrolysis reaction. Phenolphthalein indicator is pink in alkaline solution and becomes colourless at pH values below 8.3.

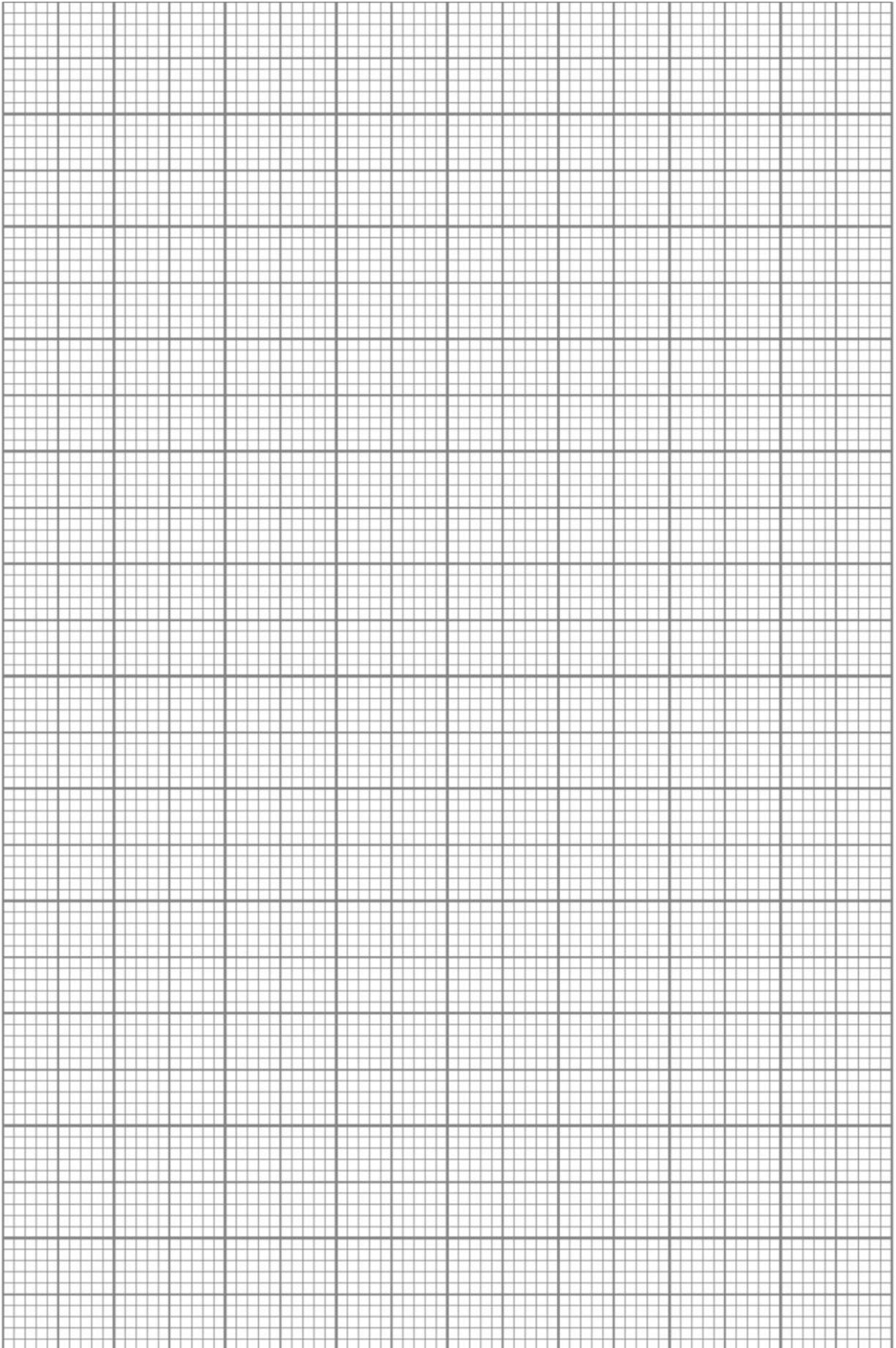
Table 1 shows the solutions used in this experiment and the different combinations prepared for test-tubes 1 to 7. The results of this experiment are tabulated in **Table 2**.

Solutions	Test-tube number						
	1	2	3	4	5	6	7
7 cm ³ Solution A (100% milk concentration)	✓						✓
7 cm ³ Solution B (80% milk concentration)		✓					
7 cm ³ Solution C (70% milk concentration)			✓				
7 cm ³ Solution D (50% milk concentration)				✓			
7 cm ³ Solution E (25% milk concentration)					✓		
7 cm ³ Solution F (10% milk concentration)						✓	
7 cm ³ sodium carbonate (Na ₂ CO ₃) solution	✓	✓	✓	✓	✓	✓	✓
5 cm ³ lipase solution	✓	✓	✓	✓	✓	✓	
5 cm ³ boiled lipase solution							✓
20 drops phenolphthalein indicator	✓	✓	✓	✓	✓	✓	✓

Milk Concentration	Test-Tube Number	Reaction Time (T) (in minutes)	Rate of Reaction (V=1/T) (in min ⁻¹)
100%	1	3.97	0.252
80%	2	4.00	0.250
70%	3	4.34	0.230
50%	4	6.45	0.155
25%	5	13.16	0.076
10%	6	no colour change	not applicable
100%	7	no colour change	not applicable

- 3.1. Use the graph paper (next page) to plot the results in **Table 2** to show the relationship between milk concentration and the rate of the reaction. **[four marks]**

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DO NOT WRITE ABOVE THIS LINE

3.2. Comment on the shape of the graph and discuss it in terms of substrate concentration, enzyme-substrate complexes and enzyme saturation.

[four marks]

3.3. No colour change was observed in both Test-tubes 6 and 7. Give an explanation for these results.

[two marks]

3.4. Test-tube 7 was used as a control. Explain this statement.

[one mark]

3.5. What would happen if 1 cm³ of bile salt were added to each test-tube? Would this affect the rate of enzyme reaction? Give reasons for your answers.

[two marks]

DO NOT WRITE ABOVE THIS LINE

3.6. Why was sodium carbonate (Na_2CO_3) added to each test-tube?

[one mark]

3.7. Before starting the experiment, the lab technician prepared two colour standards.

3.7.i. What are colour standards used for?

[one mark]

3.7.ii. Deduce the nature and colour of these standards and describe what they represent in the reaction.

[three marks]

[Total: Eighteen marks]

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MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

UNIVERSITY OF MALTA, MSIDA

MATRICULATION EXAMINATION
ADVANCED LEVEL
SEPTEMBER 2015

SUBJECT:	BIOLOGY
PAPER NUMBER:	IV – <i>Practical</i>
DATE:	28 th August 2015
TIME:	1 hour 30 minutes

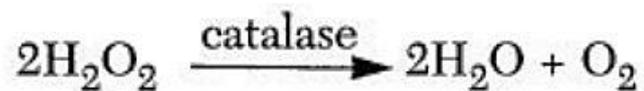
Directions to Candidates

- 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 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. Hydrogen peroxide is a chemical produced as a by-product of metabolic reactions. It can be highly toxic if accumulated in the cells. Catalase catalyses the breakdown of hydrogen peroxide into oxygen and water according to the following equation:



Several factors, for example pH, affect the rate of reaction of the enzyme catalase. Catalase can be found in the potato tuber.

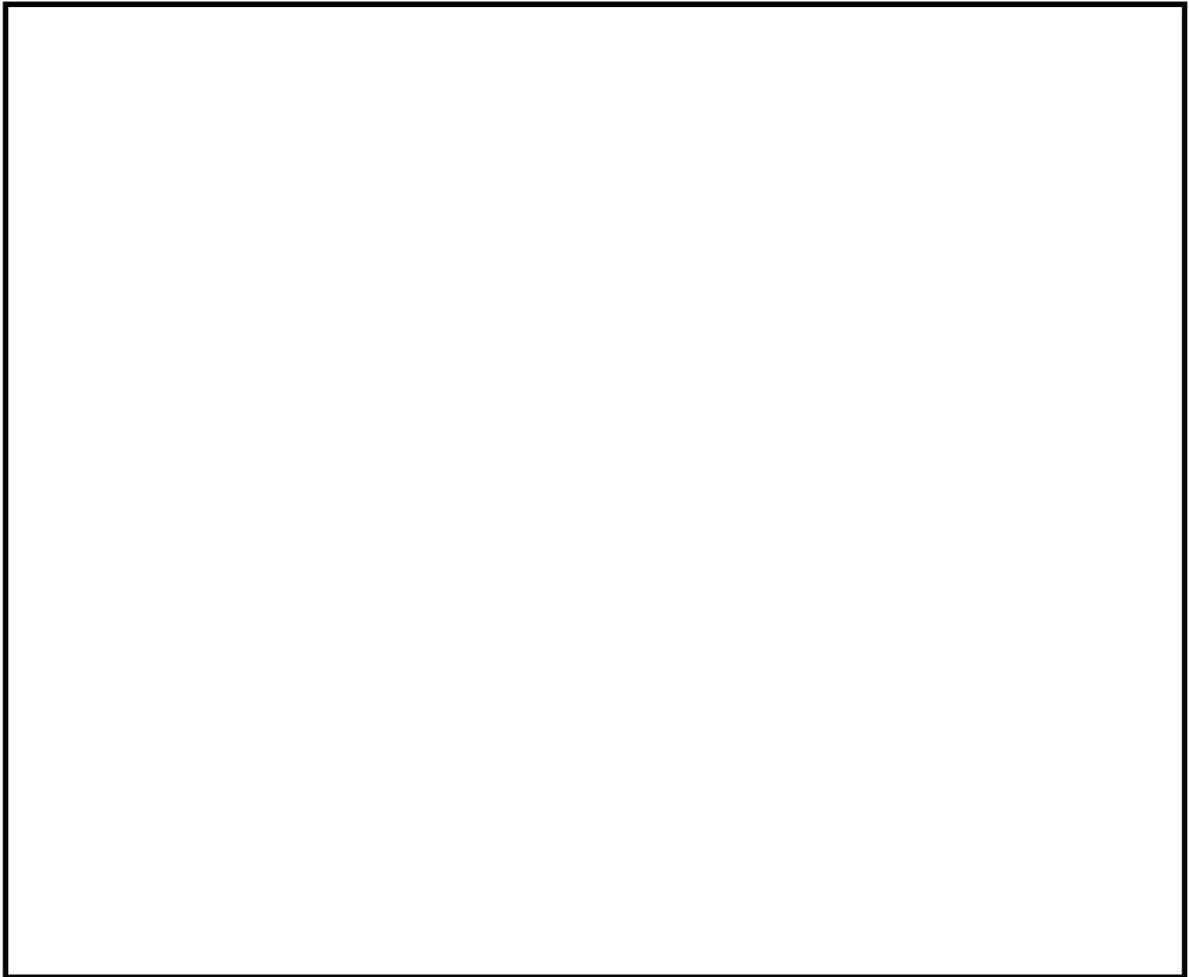
You are required to devise and implement an experiment to determine the effect of pH on the rate of reaction of the enzyme catalase.

You are provided with the following materials:

- Potato strips;
- 5% Hydrogen Peroxide;
- pH buffer solutions: pH 4, pH 7, pH 9 and pH 11;
- Other laboratory apparatus as required.

Candidates are advised to use 5 cm³ of each solution during this experiment.

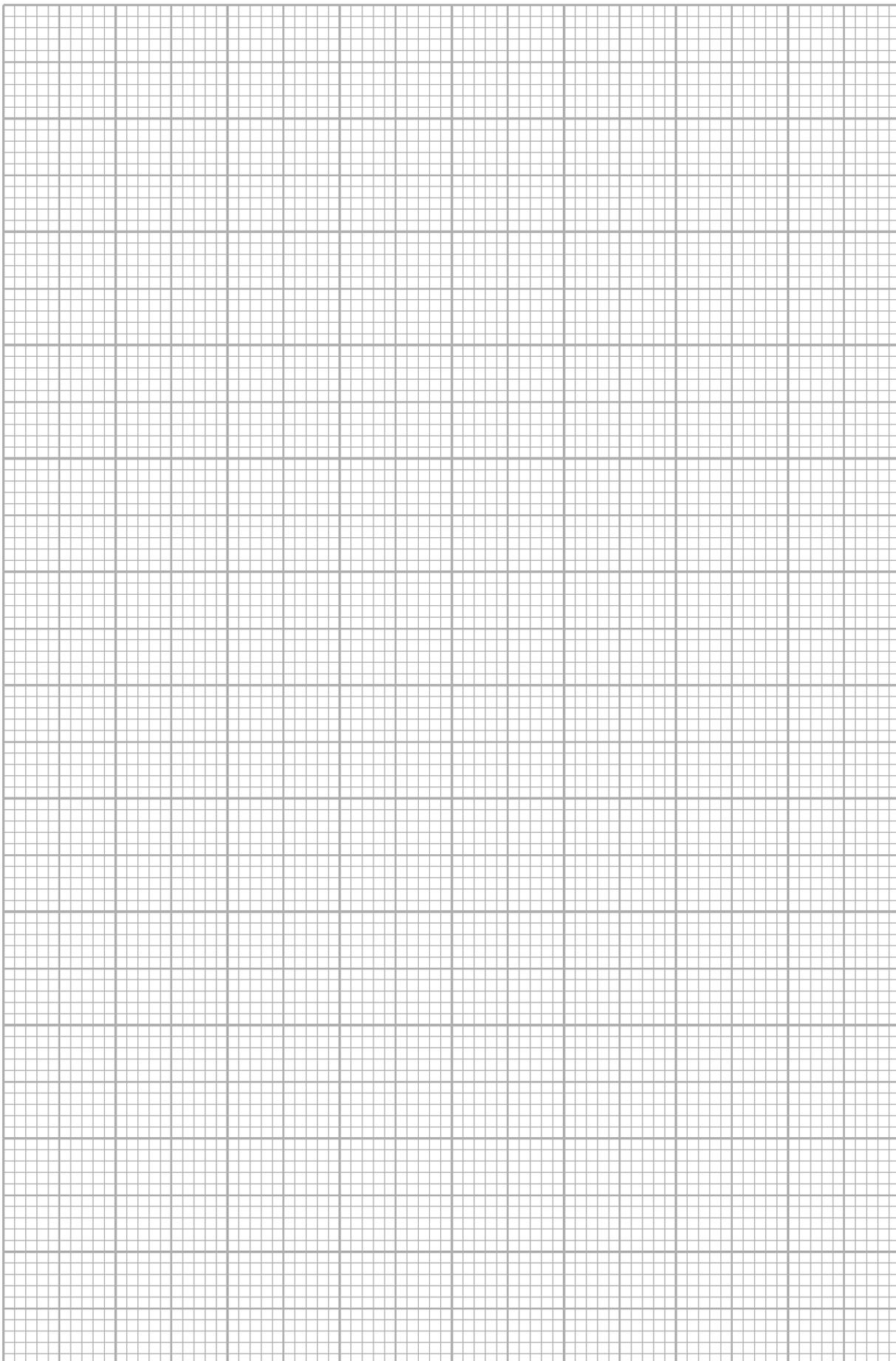
- 1.2. Devise and compile a suitable table for recording your results. Do not enter any results in the table at this stage. Use the space below for the results table.



[seven marks]

Carry out the investigation that you devised and insert the results in the table you prepared as your answer to Question 1.2.

1.3. Use the graph paper below to draw a graph of rate of reaction against pH. [six marks]



1.7. List TWO sources of error in your investigation.

[two marks]

1.8. Explain how the rate of reaction would change if old potatoes are used.

[two marks]

1.9. Copper sulphate is an inhibitor of catalase. What would happen to the rate of reaction if copper sulphate is added to the reaction?

[two marks]
[Total: Forty marks]

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