AM 05/III. 04 **INDEX NUMBER:_____**

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

MATRICULATION CERTIFICATE EXAMINATION
ADVANCED LEVEL
MAY SESSION 2004

Subject Title	**BIOLOGY**
Paper No./Title	**Paper 3**
Date	**28th May 2004**
Time	**4:00 p.m. to 5:30 p.m.**

Directions to Candidates

- *Write your index number in the space at the top right-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	40	30	20	90

ADVANCED BIOLOGY III

1. A researcher intends to investigate the effect of ethanol on the rate of anaerobic respiration of glucose by yeast. The researcher decides to determine the rate of respiration using a colorimetric method in which alkaline phenolphthalein indicator (an indicator of *p*H) changes colour from purple-red to colourless as a result of increased acidity derived from the fermentation of glucose.

   Step 1:
   The researcher prepared four water baths, labelled A, B, C and D maintained at temperatures of 20°C, 30°C, 40°C and 50°C respectively.

   Step 2:
   The researcher prepared eight flat-bottomed tubes and introduced the following into each of them:
   $5cm^3$ suspension of yeast cells
   $5cm^3$ glucose solution
   $5cm^3$ alkaline phenolphthalein indicator
   $5cm^3$ distilled water

   The eight flat-bottomed tubes and their contents were placed in the water baths described in Step 1. Two tubes were placed in each water bath.

   Step 3:
   The tubes were removed from the water baths as soon as the mixture turned colourless. The time taken for each mixture to decolourise was recorded.

   Step 3:
   The researcher prepared two flat-bottomed tubes and introduced the following mixture, containing 25% ethanol by volume, into each of them:
   $5cm^3$ suspension of yeast cells
   $5cm^3$ glucose solution
   $5cm^3$ alkaline phenolphthalein indicator
   $5cm^3$ absolute ethanol

   These two flat-bottomed tubes and their contents were placed in a water bath maintained at 30°C. The time taken for each mixture to decolourise was recorded.
   Step 4:
   The procedure outlined in Step 3 was repeated with mixtures containing 12.5%, 6.25%, 3.125% and 1.5625% ethanol by volume.

   The results obtained were recorded in Table 1 and Table 2.

Table 1: time taken for yeast & glucose mixture to decolourise

Temperature of incubation (°C)	Mean time required for colour change in indicator (min)
20	40
30	20
40	11
50	No change

Table 2: time taken for yeast & ethanol mixture to decolourise

% ethanol by volume	Mean time required for colour change in indicator (min)
0	20
1.5625	28
3.125	39
6.25	53
12.5	No change
25.0	No change

The rate of respiration, *R*, may be calculated as follows:

$$R = \frac{100}{t}$$

Where *t* is the time taken, in minutes for a mixture to decolourise.

1.1 Complete the following table:

Temperature of incubation (°C)	Rate of Respiration, *R*
20	
30	
40	
50	0

[three marks]

1.2 Plot a graph of *R* (y-axis) with temperature of incubation (x-axis). **Use the squared paper at the end of this answer booklet.**

[five marks]

1.3 Complete the following table:

% ethanol by volume	Volume of ethanol required (cm^3)	Rate of Respiration, *R*
0		
1.5625		
3.125		
6.25		
12.5		0
25.0	5	0

[nine marks]

1.4 Plot a graph of *R* (y-axis) with % ethanol (x-axis). **Use the squared paper at the end of this answer booklet.**

[five marks]

1.5 Briefly describe the **effect** of each of the following factors on *R* in yeast:

Temperature:

[three marks]

Ethanol:

[three marks]

1.6 Suggest an explanation to account for the effect of temperature on *R* in yeast.

[three marks]

1.7 Suggest an explanation to account for the effect of ethanol concentration on *R* in yeast.

[three marks]

1.8 Why did the researcher use *distilled* water (as opposed to tap water or commercial bottled water) in this investigation?

[two marks]

1.9 Suggest ONE precaution that should be taken before starting the experiment.

[two marks]

1.10 Suggest ONE possible source of error that may be influencing the result obtained.

[two marks]

[Total: forty marks]

2. A group of researchers set out to investigate the effect of removing a top predator from an intertidal rocky shore community. They selected two adjacent areas (8m x 2m). The top predator (a starfish, *Pisaster* sp.) was removed from one of the areas (Area A). The other area was left untouched as a control (Area B). The areas were monitored periodically and any predator species removed as necessary from Area B throughout the duration of the investigation. The following data represent the mean number of species after a period of two years:

Table 3

Prey Species	**Number of individuals in Area A**	**Number of individuals in Area B**
Barnacle	5	10
Whelk	0	15
Mussel	40	25
Chiton	0	10
Limpet	0	19

2.1 Suggest a null hypothesis for this investigation.

[two marks]

2.2 Name a statistical test that may be used to determine whether the abundance of prey species in Area A is significantly different from the abundance in Area B. Justify your choice of technique.

Statistical test:

Justification:

[six marks]

2.3 Describe one method, other than direct counting, through which the size of the barnacle population may be measured.

[four marks]

Simpson's Index of biological diversity, *D*, is measured according to the following relationship:

$$D = \frac{N(N-1)}{\sum n(n-1)}$$

where *N* is the total number of individuals in a particular area
n is the number of individuals belonging to a particular species

2.4 Calculate Simpson's Index for Area A.

[three marks]

2.5 Calculate Simpson's Index for Area B.

[three marks]

2.6 Simpson's Index does not always function reliably in surveys where biological diversity needs to be measured very accurately. What property of Simpson's Index is likely to reduce its accuracy and, hence, its validity?

[three marks]

2.7 What conclusions may be drawn regarding the effect of *Pisaster* on other invertebrates in this habitat?

[four marks]

2.8 Suggest ONE shortcoming in the design of this experiment.

[three marks]

2.9 Suggest ONE possible source of error that may be influencing the result obtained.

[two marks]

[Total: thirty marks]

3. The figure below shows outline drawings of four Protoctista collected from a freshwater pool.

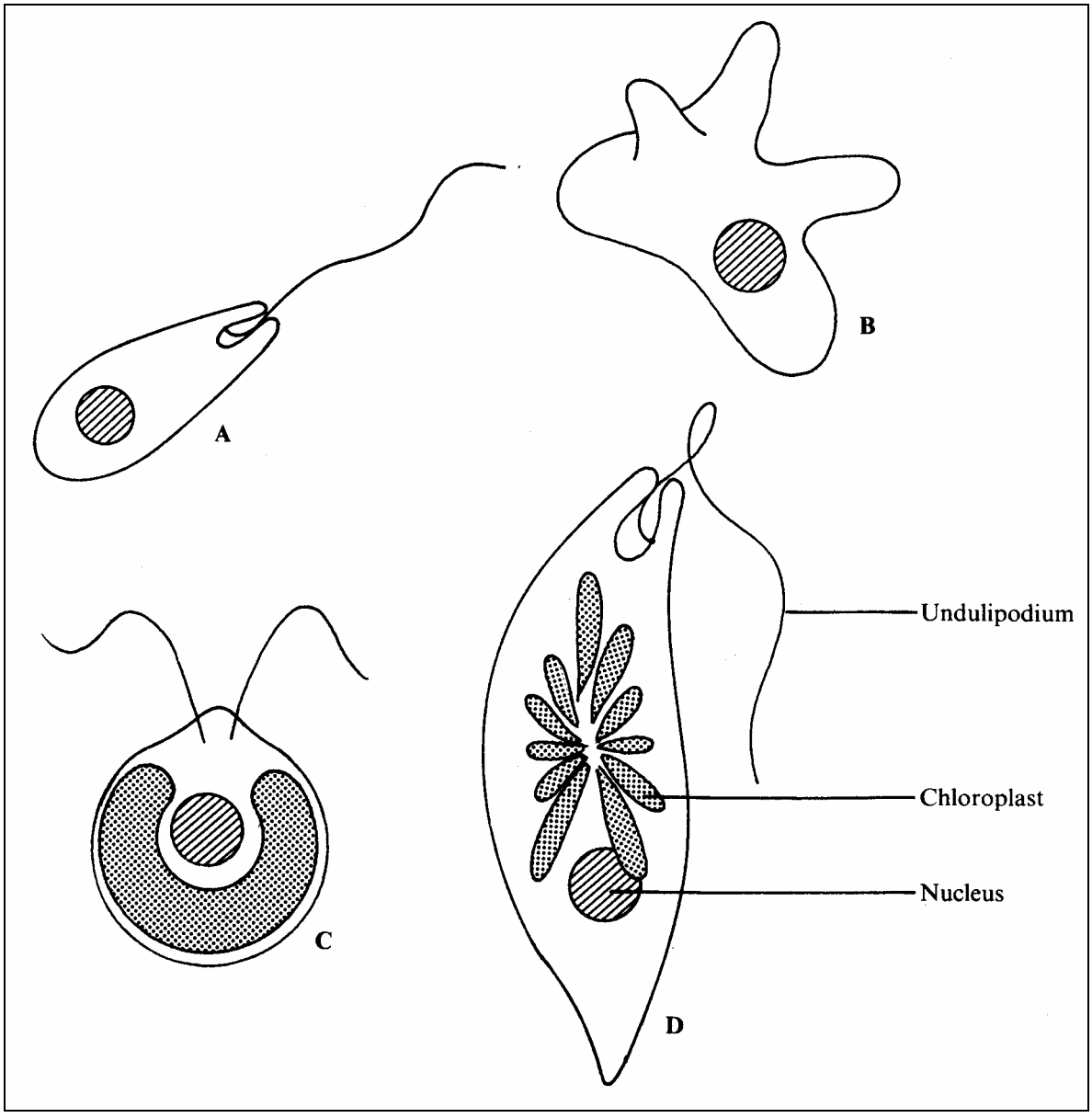

Figure 1

3.1 What are Protoctista?

_____

_____

_____

[three marks]

3.2 Describe how you would prepare a temporary mount in order to enable examination of these specimens though a light microscope.

[three marks]

3.3 How would you calculate the magnification you were using to observe the specimen?

[two marks]

3.4 List **ONE** advantage and **ONE** disadvantage of using the high power objective lens of a light microscope to observe such organisms.

[two marks]

3.5 Organism D is represented at a magnification of 400 times. Calculate the length of its body (without the undulipodium) in micrometres.

[three marks]

Question 3 continues on the next page.

3.6 Use features visible in the drawings in Figure 1 to construct a dichotomous key that would enable you to distinguish these organisms from one another.

[seven marks]

[Total: twenty marks]