

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

MATRICULATION CERTIFICATE EXAMINATION  
ADVANCED LEVEL  
SEPTEMBER (*SUPPLEMENTARY*) SESSION 2003

Subject Title	<b>BIOLOGY</b>
Paper No./Title	<b>Paper 2</b>
Date	<b>September 2003</b>
Time	<b>4:00 p.m. to 7:00 p.m.</b>

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**Directions to Candidates**

- *Answer ALL questions 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 best two answers shall be taken into consideration.*
  - *If more than one question from Section C is attempted, only the better 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.*
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## SECTION A (Answer **all** questions in this section):

1. Read the extract below carefully and afterward, from the information given and from your knowledge of biology, answer the questions that follow. The numerals in the left-hand margin are line numbers.

### **Docking blocking drug hope for HIV**

5 An experimental molecule which stops the HIV from entering cells could pave the way to a new class of HIV inhibitor drugs, suggests a study by US researchers. A new weapon against the virus would be especially valuable given that resistance to established drug therapies is growing. These mainly target the HIV's replication. The drug, called BMS-378806, successfully halted the HIV-1 virus from penetrating cells in the lab - this strain infects over 42 million people. It also showed no harmful effects when tested in dogs, rats and monkeys.

10 It is one of a new class of HIV drugs with the potential to become a "valued addition to our current armamentarium of antiretroviral drugs," write the team that conducted the study, at Bristol-Myers Squibb in Connecticut. Pin Fang Lin, who led the team, is "cautiously optimistic" about the drug's potential in humans. The molecule could be a "potent antiretroviral drug" and is a "most promising start" say Áine McKnight and Robin Weiss at University College London in the UK, in an editorial accompanying the *Proceedings of the National Academy of Sciences* paper.

20 Most current HIV drugs inhibit vital enzymes, called reverse transcriptase and protease, that the virus needs. But resistance to these drugs is growing, says the team, with almost 20 per cent of newly diagnosed HIV patients being infected with resistant viruses. BMS-378806 works by preventing HIV from "docking" with a cell, and then squeezing inside. The molecule attaches itself to a protein on the surface on HIV's outer coat that would otherwise dock with a molecule called CD4 on the surface of cells.

30 Tests in the lab showed "potent inhibitory" effects against HIV-1, but not HIV-2. A two-week study in rats showed the drug could be safely given every day in an oral form. It was also safe in dogs and monkeys. Importantly, preliminary data showed the drug was effective against HIV strains that were resistant to more conventional drug therapies.

35 The concept of stopping HIV by interfering with the first stage in its infection process is not new. However, this is the first time this particular docking system has been targeted. McKnight and Weiss note that the HIV coat protein, called gp120, is one of the better-preserved features of the highly changeable virus. HIV's ability to rapidly evolve has been the major challenge in the search for a cure.

Adapted from: New Scientist. 19 August 2003.

- 1.1 What do the initials HIV represent?

[one mark]

1.2 To what class of virus does HIV belong? **[one mark]**

1.3 What is the mode of action of current drugs targeted at inhibiting the HIV virus? **[three marks]**

1.4 How does the HIV virus develop drug resistance? **[four marks]**

1.5 What are the advantages of this newly developed drug? **[three marks]**

1.6 In your opinion, how valid is a two-week study to show ‘a potent inhibitory’ effect of this drug on HIV? (line 27) **[four marks]**

1.7 What, in your opinion, are the disadvantages associated with oral administration of drugs when carrying out such a study? (line 29) **[four marks]**

**[Total: twenty marks]**

2. A researcher working on the ecology and life cycle of a ground beetle, *Phaleria* sp., cultures the beetle in captivity so as to be able to observe changes in the beetle’s population structure. The table below represents some of the data collected over a number of weeks.

<b>Time (in weeks)</b>	<b>No. of male beetles</b>	<b>No. of female beetles</b>
0-2	100	150
3-5	98	147
6-8	96	145
9-12	94	143
13-15	91	141
16-18	88	139
19-21	86	68
22-24	85	28
25-27	45	27
28-30	15	26

- 2.1 What is the sex ratio in the population
- (a) two weeks after the start of the experiment
  - (b) twelve weeks after the start of the experiment
  - (c) eighteen weeks after the start of the experiment
  - (d) twenty-four weeks after the start of the experiment
  - (e) thirty weeks after the start of the experiment
- [five marks]**
- 2.2 Express the variation of sex ratio with time as a histogram. Use the squared paper on your answer booklet for this purpose.
- [three marks]**
- 2.3 How does the sex ratio vary over the duration of the experiment?
- [three marks]**
- 2.4 Calculate the percentage survival of male beetles and the percentage survival of female beetles after
- (a) 15 weeks
  - (b) 27 weeks
- from the start of the experiment.
- [two marks]**
- 2.5 How do the patterns of survival of male and female beetles differ over time?
- [three marks]**
- 2.6 The researcher has carried out the same experiment over two successive years. He suspects that mortality amongst female beetles was significantly higher this year than during the previous year. How can he confirm his suspicions?
- [two marks]**
- 2.7 The taxonomic order in which beetles are classified (Order Coleoptera), is the most diverse group, in terms of species richness, on Earth. Within which phylum are beetles classified?
- [one mark]**
- 2.8 Suggest ONE adaptation that has made beetles so successful.
- [one mark]**

**[Total: twenty marks]**

## **SECTION B**

(Answer any **TWO** questions from this section; your answers should take the form of essays. Each question carries twenty marks).

3. Discuss the role of carbohydrates in plant structure and function.
4. Reproduction is an essential feature of life that has to be able to provide both continuity and change. Discuss.
5. In recent years, humans have shaped their environment to a considerable and irreversible extent. Discuss this statement in relation to the major pollution issues you have studied.
6. Variation among organisms and between individuals of the same species is purely the result of genetic differences. Discuss this statement.

## **SECTION C**

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

7. Write **brief** notes on the evolutionary significance of each of the following structures:

- 7.1 Light microscopy
- 7.2 Transmission electron microscopy
- 7.3 Scanning electron microscopy
- 7.4 Freeze-fracturing

**[five marks each]**

**[Total: twenty marks]**

8. Use your knowledge of biological processes to comment on following:

- 8.1 C3 plants are better adapted to temperate regions than C4 plants.
- 8.2 C4 plants are better adapted to tropical regions than C3 plants.
- 8.3 Cells in the palisade mesophyll of the leaf are arranged vertically rather than horizontally.
- 8.4 Most leaves appear greenish in colour. Some change colour in autumn.

**[five marks each]**

**[Total: twenty marks]**