AM 05/II.05M

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

MATRICULATION CERTIFICATE EXAMINATION
ADVANCED LEVEL
MAY 2005

SUBJECT:	BIOLOGY
PAPER NUMBER:	II
DATE:	16th May 2005
TIME:	4.00 p.m. to 7.00 p.m.

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.*

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.

DEADLY POISON SAVES LIVES?

Preliminary research shows that a natural compound in some snake venoms may prevent the growth of cancerous tumours, potentially transforming one of nature's deadliest toxins into a curative agent.

"Snakes use venom to alter biological functions, and that's what medicine does too," explained John Perez, director of the Natural Toxins Research Centre at Texas A&M University-Kingsville.

Of the nearly 3,000 species of snakes in the world, about 650 are venomous. Ten of the most deadly live in Australia, making it a logical base for new experiments. "We knew Australia could be a rich source of drugs because there are numerous venomous creatures here," said Tony Woods, a biologist at the University of South Australia in Adelaide. Woods is co-leader of a project to investigate whether the toxins in venom can be used to destroy cancerous tumors.

Snake venoms are an exquisite cocktail, composed of as many as a hundred different peptides, enzymes, and toxins which help digest the snake's prey. Not only are the venoms of every snake species different, there are also subtle variations within each species. There are differences between venoms of juveniles and adults, and even among different geographic regions. The variations between venom types and the number of venomous snakes worldwide create a rich molecular hunting ground for researchers, like Woods, seeking to design new drugs.

The fascination with snake venom is not new to science and they have always been of interest to medical researchers. Anti-venoms were first produced a century or more ago. Albert Calmette demonstrated that it was possible to "hyper-immunize" an animal against snakebite by graduated and increased regular dosage of that animal with the venom of that snake. He further demonstrated that a second animal could be saved after snakebite by introducing the serum of the immunized creature. This discovery is still the basis of the production of modern anti-venoms. Nowadays, the animal of choice is the horse. Increasing doses of venom are injected until the animal becomes hyper-immunized and thereafter blood is drawn and the serum removed. The rest of the blood is transfused back into the animal. The serum then passes through various stages of refinement before it is released for use on humans. It contains immunoglobulins and these are digested by pepsin to isolate the antigen that neutralizes the venom. Both ‘monovalent’ and ‘polyvalent’ serum can be produced in this way. In a hospital situation, a patient receiving treatment for a snake bite, is initially administered anti-histamines and hydro-cortisones prophylactically. Then a small test sample of antivenom is administered prior to a full dose.

As early as 1949 it was shown that an enzyme from the snake species *Bothrops* induces vasodilation resulting from the production of a hypotensor neuropeptide, bradykinin. To date, several venoms have been isolated and their functions identified,

ranging from alpha-neurotoxins known to block neuromuscular transmission by linking onto cholinergic receptors found on skeletal muscle fibres to myotoxins that lead to muscular degeneration by interacting with a voltage-gated sodium canal.

Woods' group are growing keen. They have just isolated a compound in snake venom that specifically disrupts the endothelial cells which line the inner surface of blood vessels. "It causes the cells to separate from one another, which kills them," Woods said. They think this might help them in developing a cure for certain cancerous growths.

Woods anticipates that he will begin testing the venom-derived toxin in animals within the year. Those results will reveal whether the drug is suitable for human clinical trials.

"I don't actually like snakes, they scare me to death, but I'm fascinated by their venom," Woods said. "So long as it's provided to me in nice plastic tubes, I'm very comfortable with handling it."

1.1 What is *venom*? What is its possible adaptive function in snakes?

[two marks]

1.2 Many types of venom target the nervous system of the snake's prey (lines 43-45). What selective advantage may be derived from targeting the nervous system rather than other physiological systems?

[two marks]

1.3 Why should the venom of juvenile snakes and adult snakes from the same species be different?

[two marks]

1.4 Why do immunologists use horses, as opposed to other possible choices of animal, during the production of anti-venom? (lines 30-31)

[two marks]

1.5 What is an *immunoglobulin*? (line 35)

[two marks]

1.6 In molecular terms, what is occurring within an animal during the hyper-immunisation process? (lines 26-28)

[three marks]

1.7 Why is the horse serum "refined" before being released for use on humans? (lines 33-34)

[one mark]

1.8 Why are patients being treated for snake bite given a small dose of anti-venom prior to administration of the full dose? (lines 38-39)

[one mark]

1.9 What is the difference between a monovalent serum and a polyvalent serum? (line 36)

[one mark]

1.10 What common medical condition do you predict could be controlled by the venom obtained from the *Bothrops* species? (lines 41-42)

[one mark]

1.11 How is venom's ability to disrupt endothelial cells of the inner surface of blood vessels correlated with a possible cure for cancer? (lines 48-52)

[two marks]

1.12 Why would treatment with venom represent a better method of curing cancer than more traditional chemotherapeutic methods?

[one mark]

[Total: twenty marks]

2. Limpets are often the dominant mobile herbivores on temperate and tropical rocky shores, and their limits of distribution are thought to be set by physical extremes. *Helcion pectunculus* is one of the most abundant limpet grazers in the upper intertidal zone of many South African rocky shores. During diurnal high tides and low tides this limpet is known to retreat to crevices in the rocks. A study was carried out to test whether physical factors determine the behaviour of this species. Several parameters, namely, size-distribution in crevices, relative humidity, rock surface temperatures, and limpet body temperature were measured. The size-distribution of *H.pectunculus* was determined by removing all the limpets from 25 different west-facing crevices all which had a depth of 100mm and a width of 0.25m. Different rows of limpets were recognized and the shell length was determined. The results obtained are represented below.

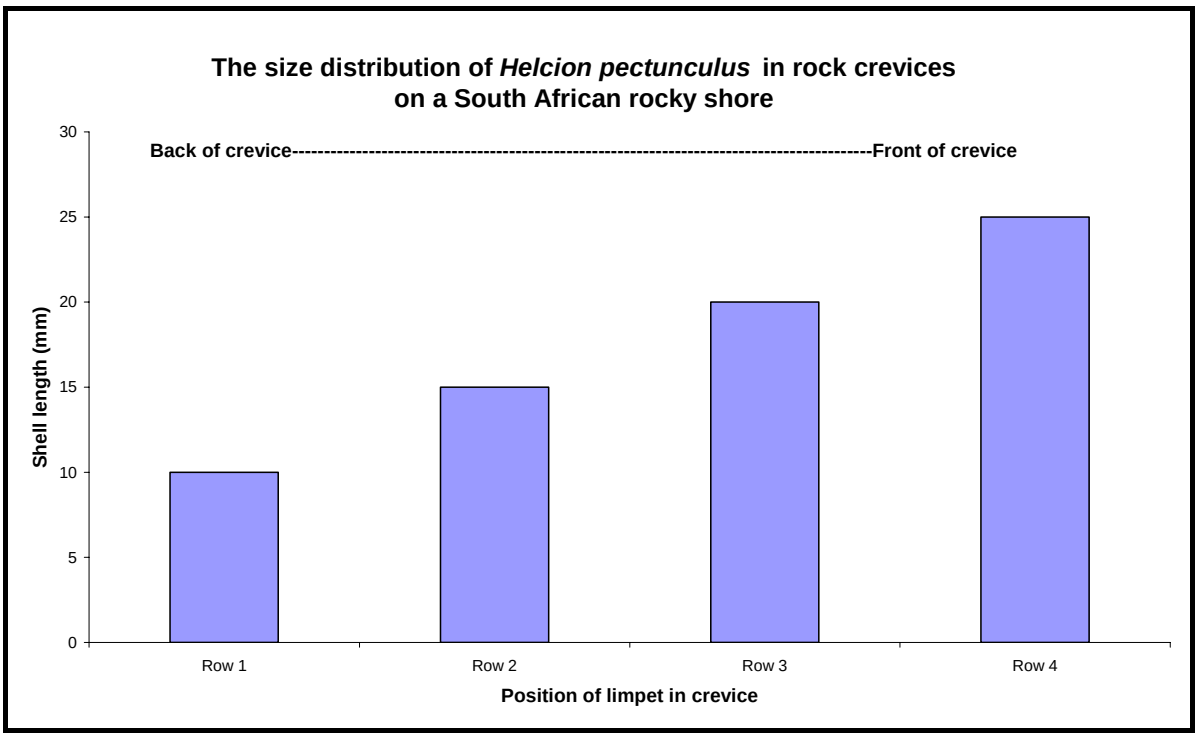

Figure 1

Relative Daytime humidity			
Spring		Autumn	
Inside Crevice	Outside crevice	Inside Crevice	Outside crevice
81.9 ±1.3%	72.8 ±2.8%	68.2 ±4.1%	58.9 ±2.9%

Relative Daytime Temperature			
Spring		Autumn	
Inside Crevice	Outside crevice	Inside Crevice	Outside crevice
24.0 ±0.7^{O}C	21.4 ±0.2^{O}C	17.9 ± 0.6^{O}C	21.1 ± 0.8^{O}C

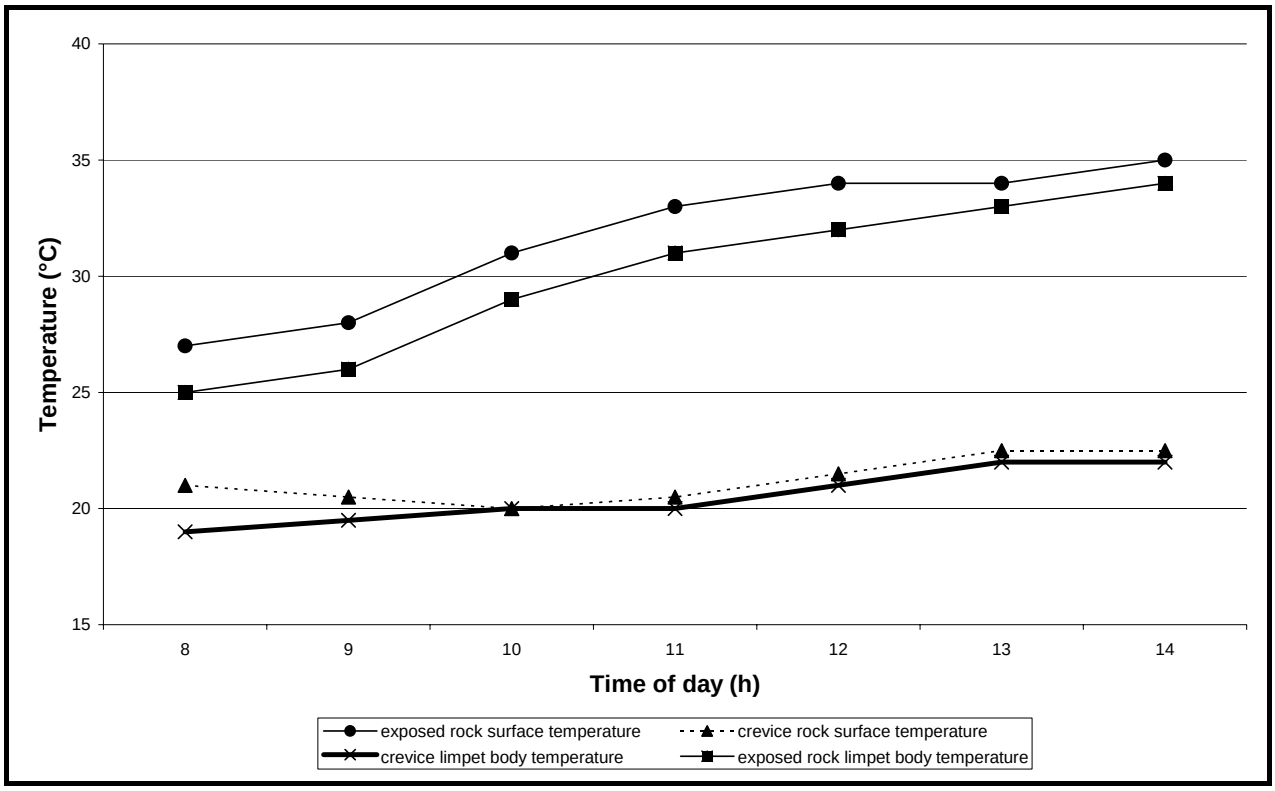

Figure 2: A comparison between rock surface temperatures and limpet body temperatures both inside a crevice refuge and while exposed to direct sunlight over a diurnal period of emergence on a mid-summer day. The graph shows data during the period 0800-1400.

2.1 What do you understand by the term '*intertidal*'?

[three marks]

2.2 Comment on the size-distribution of *Helcion pectunculus* within crevices.

[three marks]

2.3 In view of the distribution of the limpets described in your answer to question 2.2, suggest a possible foraging pattern among individuals occupying the same crevice.

[four marks]

2.4 Is it justifiable to state that crevices provide a stable and buffered environment to the limpets?

[four marks]

2.5 What other parameter, not considered in this study, could be responsible for the absence of *Helcion pectunculus* individuals from other regions of the coastal zone?

[three marks]

2.6 Suggest how the researcher could improve the method of investigation in order to obtain more valid results.

[three marks]

[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. Describe the general principles involved in the functioning of the nervous system in humans.

4. Compare and contrast shoot and root morphology (external structure) and anatomy (internal structure). Relate the similarities and differences you notice to the function of these structures.

5. The development of a coelom was a major step in the evolution of the animal body plan. Discuss.

6. Write an account on 'The role of proteins in animal locomotion'.

SECTION C

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

7. Use your knowledge of genetics to explain the following:

    7.1 Crossing two pink-flowered snapdragons together is not a certain method of obtaining pink-flowers in a subsequent generation of plants.
    7.2 Haemophilia and colour blindness are more frequent in males than in females.
    7.3 When two purple-flowered, long pollen sweet pea plants were crossed together, 75% of the next generation of plants was purple-flowered, long pollen, and 25% were red-flowered, short pollen varieties.
    7.4 A heterozygous woman with blood group A and a heterozygous male with blood group B could have four children, all with a different blood group.

    [five marks each]

    [Total: twenty marks]

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

    8.1 A single closed circulatory system would be an inefficient method of blood circulation in mammals.
    8.2 Predators generally hunt lizards in the early morning.
    8.3 Internal fertilisation is an adaptation to life on land.
    8.4 Several insect-pollinated plants release volatile organic compounds at the time of flowering.

    [five marks each]

    [Total: twenty marks]