AM 05/II.04

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 2**
Date	**19th May 2004**
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.

Spare Parts

On New Year's Eve 2003 Dr Martin Evans, Professor of the School of Mammalian Genetics at Cardiff University was knighted by the Queen in recognition of his pioneering work in one of science's most controversial fields – stem cell research.

Britain is at the cutting edge of stem cell research, with some of the most progressive legislation in the world. In 2003, in fact, Britain became the first, and so far, the only country to set up a government-approved stem cell bank for creating and storing 'lines' of stem cells.

Cloning, which is illegal in most developing countries is not the reason why scientists are interested in stem cells. Rather, it is because the cells have two key properties with extraordinary medical potential. These cells are capable of reproducing indefinitely and they are 'undifferentiated'.

There are two main types of stem cell – adult and embryonic. Since the applications of adult stem cells are limited most interest has been directed towards embryonic stem cells (known as ES cells).

About 5 days into development, an embryo is made up of a ball of 50-100 cells called a blastocyst. The ES cells are derived from an inner cell mass within that ball. Within 6 days, these ES cells would have received signals instructing them how to differentiate.

One technique used by scientists to harvest the ES cells before they differentiate is called cell nuclear replacement. Here, the nucleus of an oocyte is removed carefully and replaced with the nucleus of another adult cell. The empty oocyte fuses with the new nucleus and a blastocyst then forms from the egg cell and the donor nucleus. These first stages are controversially identical to the early stages of reproductive cloning. In therapeutic cloning, however, the ES cells harvested from the blastocyst are grown in culture and used for research. It is hoped that ES cells obtained from therapeutic cloning will eventually help patients with conditions such as Parkinson's disease, a degenerative illness which destroys dopamine-producing neurones in the brain. The donor nucleus would be taken from one of the patient's own cells. The resultant stem cells would be induced to differentiate into the necessary cells and then transferred back into the patient.

There are still an enormous amount of technical challenges to overcome before this therapy can be used. While recognizing the achievements, Evans is cautious about how soon the miracles of stem cell therapy will become reality.

"It's only fair to say that we're still a long way off. The human imagination is there and the technologies, while buy no means perfect, are absolutely foreseeable. I think it'll happen within decades. Perhaps a generation ahead, we could be doing these things."

1.1 What do you understanding by the term “cloning” (line 8)

[two marks]

1.2 What do you understand by the term “line”? (line 7).

[two marks]

1.3 Why are an indefinite reproductive ability and an undifferentiated structure considered key to the process of therapeutic cloning? (lines 10-11).

[two marks]

1.4 What is the nature of the “signals” referred to in lines 17 to 18?.

[two marks]

1.5 Why are the possible applications of adult stem cells described as limited? (lines 13-14).

[two marks]

1.6 Suggest TWO ways in which reproductive cloning and therapeutic cloning may differ. (lines 23 to 27)

[two marks]

1.7 Name ONE of the “technical challenges” referred to in line 31.

[two marks]

1.8 What “miracles of stem cell therapy” may the author be referring to in line 33?

[two marks]

1.9 Suggest a reason as to why legislation in the United Kingdom specifies that this technique using stem cells is only permissible when carried out on human embryos less than 14 days old.

[two marks]

1.10 Why do you think that cloning is still illegal in most developing countries? (line 8).

[two marks]

[Total: twenty marks]

2. Tributyltin (TBT) is a chemical that is present in antifouling paints. Such antifouling agents are typically applied to the hulls of boats in order to prevent the growth of algae and barnacles which would otherwise increase drag on the craft. TBT is known to cause a phenomenon called imposex in certain gastropod molluscs. Imposex involves the masculinisation of female gastropod snails which are otherwise dioecious (have separate sexes). Female snails grow the male sexual characteristics while still retaining the female reproductive organs.

In an attempt to study this effect in Maltese waters, a researcher collected random samples of the gastropod mollusc, *Murex trunculus* from various bays around Malta during one particular summer. The degree of imposex was determined and expressed as Percentage Imposex Occurrence and by means of the Relative Penis Size (RPS) index which is a measure of the female penis length expressed as a percentage of the male penis length. The data collected is shown in the table below:

Boating Activity	**Sampling Site**	**% Imposex occurrence**	**Male Penis Length (mm)**	**Female Penis Length (mm)**	**Relative Penis Size Index (RPS)**	**Mean Shell length (mm)**
Limited boating activity	White Tower Bay	23.52	9.25	0.77	8.27	19.3
	Anchor Bay	35.0	7.82	0.71	9.07	15.5
	Bahar ic-Caghaq	96.43	9.91	2.77	27.93	22.0
Recreational/seasonal boating activity	Mellieha Bay	68.75	8.16	2.38	29.11	23.0
	Ghajn Tuffieha Bay	71.42	7.21	1.64	22.77	20.4
Moderate boating activity of small sea craft	Ghar Lapsi	100	7.66	4.13	53.91	35.0
	Zurrieq	63.63	10.21	2.82	27.59	36.4
	Marsascala	100	10.3	8.45	81.65	42.5
	Marsaxlokk	100	8.00	7.18	89.75	37.9
Commercial boating activity	Rinella	100	14.0	11.74	83.83	68.5
	Delimara	100	8.37	1.35	16.19	65.3
Yacht marinas	Ta'Xbiex	100	12.0	12.85	107.05	72.4
	Manoel Island	100	9.67	9.71	100.49	70.1

2.1 Comment on the Percentage Imposex Occurrence in the various localities.

[five marks]

2.2 How may the presence of imposex in organisms living in areas of limited boating activity be explained?

[three marks]

2.3 What may the ecological implications of imposex be?

[three marks]

2.4 The larger shell size noticed in most areas where imposex occurrence was rather high was interpreted by the researcher as evidence of dying and ageing populations. Why is such an interpretation justified?

[three marks]

2.5 How may the researcher improve the statistical validity of her results?

[three marks]

2.6 Anatomical changes similar to the ones described in the passage have recently been detected in a female polar bear cub. What are the broader implications of such an observation?

[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. The pituitary gland is referred to as a "master gland" in the human body. Discuss.

4. Organelles are regarded as analogous to organs in multicellular organisms. Comment on the validity of this statement.

5. Plants and animals solve problems associated with mechanical support in different ways. Discuss.

6. Give a comparative account of processes leading to speciation in living organisms.

SECTION C

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

7. Write **brief** notes to explain the biological significance of the following:

    7.1 Habituation
    7.2 Insight learning
    7.3 Latent learning
    7.4 Associative learning

[five marks each]

[Total: twenty marks]

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

    8.1 Although C_4 plants have a greater photosynthesizing efficiency than C_3 plants less than 0.5 per cent of plants have C_4 metabolism.
    8.2 Strenuous physical exercise is associated with an increase in the volume of urine production.
    8.3 Increased height in plants may be both an advantage as well as a disadvantage.
    8.4 Positive feedback mechanisms are rare in nature.

[five marks each]

[Total: twenty marks]