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

MATRICULATION CERTIFICATE EXAMINATION
ADVANCED LEVEL
SEPTEMBER SESSION 2004

Subject: BIOLOGY
Paper Number: Paper 1
Date: 2nd September 2004
Time: 9.00 a.m. to 12.00 noon

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.*
- *The use of electronic calculators is permitted.*

For examiners' use only:

Question	1	2	3	4	5	6	7	8	9	Total
Score										
Maximum	12	10	9	12	12	10	11	13	11	100

ADVANCED BIOLOGY I

Answer ALL questions.

1. The Eastern Grey Squirrel (*Sciurus carolinensis*) may occur as two colour morphs. Individuals may be characterised by a coat that is either grey or black. Observation of squirrel populations indicates that mating between the two morphs occurs regularly and litters are often mixed, comprising both black and grey offspring. The distinct delimitation of the morphs, together with the presence of both in a single litter, suggests that a single gene is responsible for the squirrels' coat colour. It is known, from previous work, that the gene for the black morph is an autosomal dominant gene, and its allele is the recessive grey gene.

   A group of investigators carried out a survey of the squirrel population in a given area and recorded 246 grey squirrels and 61 black squirrels. It is assumed that the squirrel population conforms to the assumptions of the Hardy-Weinberg Principle.

1.1 Write an algebraic expression summarising the Hardy-Weinberg principle for two alleles. Define any symbols that you may use.

_____

_____

[two marks]

1.2 List **FOUR** conditions that a population should satisfy for the Hardy-Weinberg principle to apply.

_____

_____

_____

_____

[four marks]

Use the data given in the paragraph above to calculate the following (all working should be clearly shown):

1.3 Frequency of the dominant allele.

_____

_____

[two marks]

1.4 Percentage of heterozygotes for coat colour in the population.

[two marks]

1.5 Percentage of homozygotes for black coat colour in the population.

[two marks]

[Total: twelve marks]

2. Comment on the biological significance of the following observations:

2.1 Abandoned agricultural areas may develop into woodland areas if left undisturbed.

[two marks]

2.2 The biomass of top predators is much lower than that of organisms at the first trophic level in the same food web.

[two marks]

2.3 Removal of predators may reduce diversity of prey organisms.

[two marks]

2.4 Green Hydra (*Chlorohydra viridissima*) ingests *Chlorella*, a unicellular green alga. The algae are not digested and remain alive within the Green Hydra.

[two marks]

2.5 Dodder (*Cuscuta epithymum*) is a flowering plant that has no leaves, lacks chlorophyll and loses its roots at maturity.

[two marks]

[Total: ten marks]

3. Various micro-organisms may be exploited to produce gasohol.

3.1 What is gasohol?

[one mark]

3.2 Briefly describe the biochemical process that is exploited to produce gasohol.

[two marks]

3.3 Name **ONE** possible substrate from which gasohol may be produced.

[one mark]

3.4 Suggest a suitable microorganism that may be used to produce gasohol.

_____

[one mark]

3.5 List **TWO advantages** and **TWO disadvantages** of using gasohol, rather than more conventional fuels, as a source of energy for motor vehicles.

_____

_____

_____

[four marks]

[Total: nine marks]

4. **Figure 1** (below) shows part of the cell membrane of a eukaryotic cell.

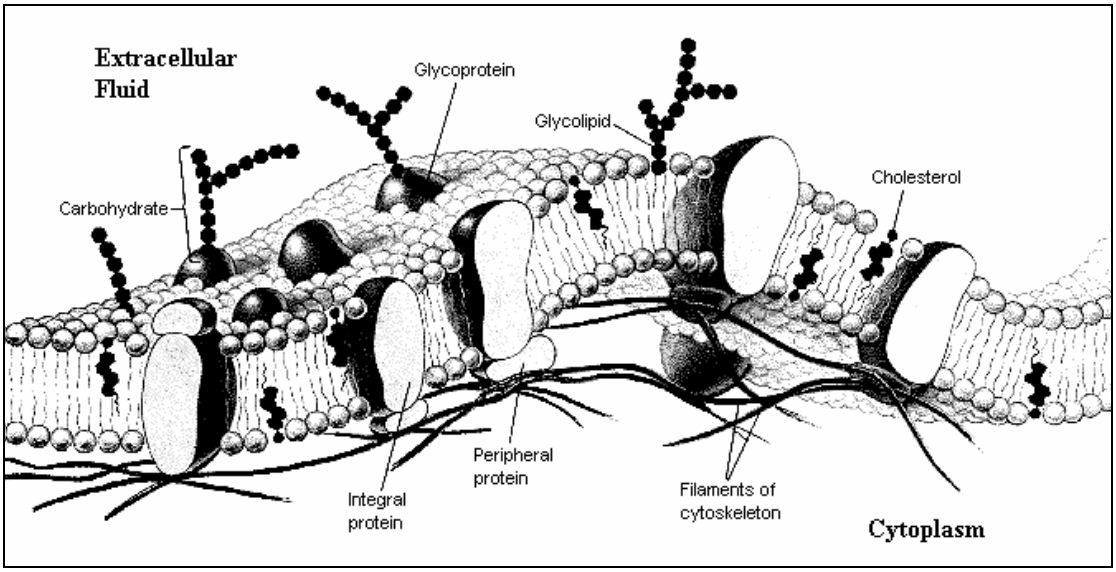

Figure 1 (modified from *Human Biology* by Daniel Chiras)

4.1 Briefly describe the structure of the phospholipid molecules that comprise the basic framework of the membrane.

_____

_____

_____

[two marks]

4.2 Give **TWO** functions of the protein molecules in the membranes.

[two marks]

4.3 What is the role of cholesterol molecules in the membrane?

[two marks]

Explain the meaning of the following terms in the context of transport across cell membranes:

4.4 Receptor-mediated endocytosis.

[two marks]

4.5 Diffusion.

[two marks]

4.6 Active transport.

[two marks]

[Total: twelve marks]

5. This question concerns the taxonomy of living organisms.

5.1 Read the paragraphs below and identify the phylum that each description refers to.

Characteristics	Phylum
Possess two layers of cells separated by a gelatinous mesoglea. These layers enclose a blind-ending coelenteron.	
Plants in which the diploid sporophyte generation is dominant and, in most cases, becomes fully independent from the gametophyte at an early age.	
Soft-bodied, metamerically-segmented coelomate organisms.	
Plants in which the haploid gametophyte forms the dominant generation. Gametophytes may be leafy or thallose. Gametophytes may form large cushions or may have erect stems or spreading stems. Anchorage is accomplished by hair-like rhizoids since roots are absent.	
Triploblastic coelomate animals in which the adults are radially symmetrical but which have bilaterally symmetrical larvae.	
Soft-bodied, bilaterally-symmetrical, unsegmented coleomate invertebrates. Generally characterized by a radula and a muscular ventral foot.	
Triplobastic, bilaterally symmetrical, acoleomate organisms.	

[seven marks]

Define the following terms:

5.2 Triploblastic.

_____

[one mark]

5.3 Acoleomate.

_____

[one mark]

5.4 Gametophyte.

_____

[one mark]

5.5 Sporophyte.

_____

[one mark]

5.6 Radula.

_____

[one mark]

[Total: twelve marks]

6. Read the passage below and insert the appropriate term in the blank spaces provided.

Carbohydrates contain the elements carbon, _____, and oxygen. The simplest forms of carbohydrates are known as monosaccharides. The most common and important monosaccharide is _____, which is a six-carbon sugar. Its formula is $C_6H_{12}O_6$. There are many monosaccharides, with the same chemical formula ($C_6H_{12}O_6$), but different structural formulae. These include fructose and _____. Disaccharides are formed when two monosaccharides are joined together by a _____. The reaction involves the formation of a molecule of _____. This kind of reaction is called a _____ reaction. A common disaccharide is _____. It is formed on digestion of starch by amylase, because this enzyme breaks starch down into two-_____ units. Polysaccharides are long chains of many monosaccharides units. _____ is the plant storage polysaccharide. It is insoluble and forms granules inside many plant cells. Starch is a mixture of amylose and amylopectin. Glycogen is similar in structure to _____. It is made by animals as their storage polysaccharide, and is found mainly in muscle and liver.

[Total: ten marks]

7. This question concerns autotrophic nutrition in plants.

7.1 What is "autotrophic nutrition"?

_____

_____

[one mark]

7.2 List **FOUR** ways in which the leaves of plants are adapted to their role in photosynthesis.

_____

_____

_____

_____

[two marks]

The diagram below **(Figure 2)** shows the absorption spectra for Chlorophyll *a* and Chlorophyll *b*.

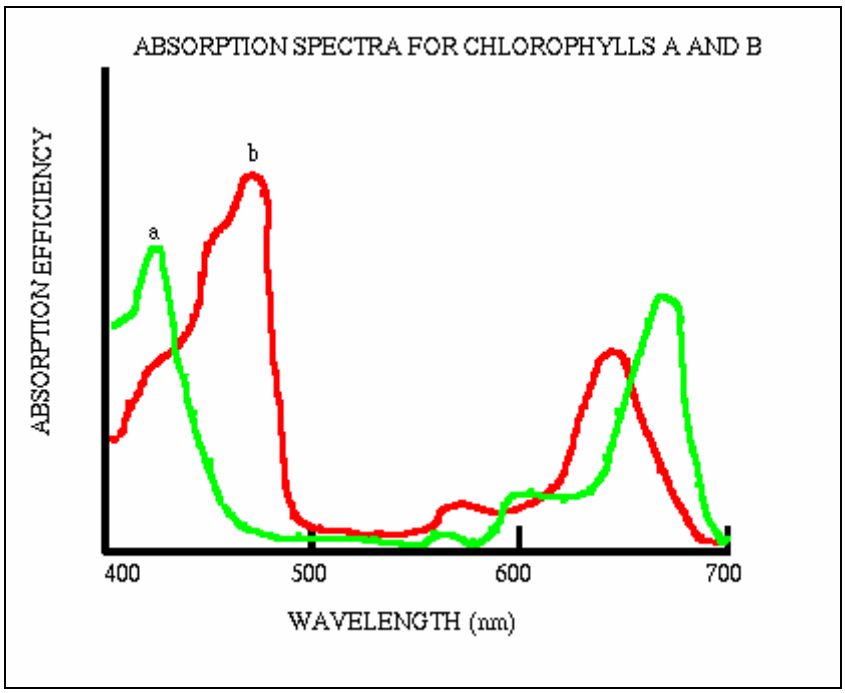

Figure 2

7.3 What is an "absorption spectrum"?

[two marks]

7.4 How does the absorption spectrum of Chlorophyll *a* differ from that of Chlorophyll *b*?

[one mark]

The graph below **(Figure 3)** compares the action spectrum for photosynthesis with the absorption spectrum of photosynthetic pigments.

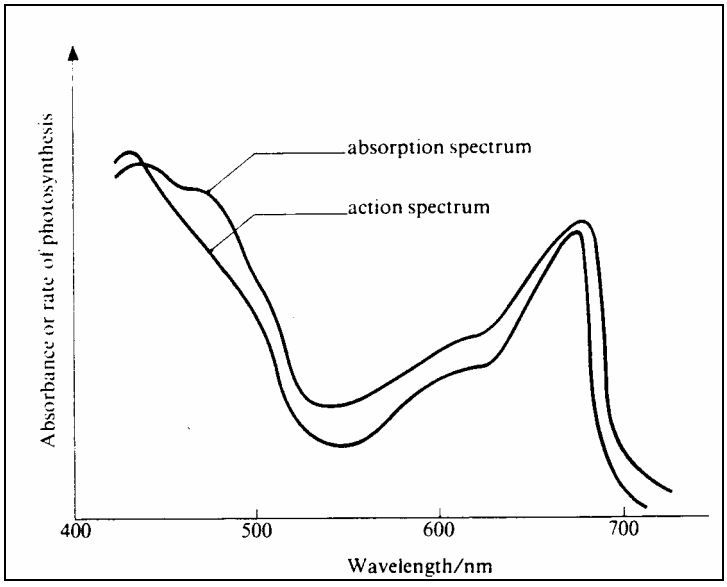

Figure 3

7.5 What is an "action spectrum"?

[two marks]

7.6 Suggest **ONE** interpretation for the close similarity of the graphs shown in **Figure 3**.

[one mark]

7.7 Suggest **TWO** reasons as to why the leaves of plants only absorb certain wavelengths of light rather than all available wavelengths.

[two marks]

[Total: eleven marks]

8. This question concerns metabolic processes in organisms.

8.1 Define "metabolism".

[one mark]

8.2 List **TWO** factors that may affect the metabolic rate of an organism and briefly describe the possible effect of each.

[two marks]

State whether the statements below are true or false. If the answer is **FALSE**, explain why it is so.

8.3 Most of the ATP produced from the aerobic metabolism (cellular respiration) of glucose results from oxidative phosphorylation in the mitochondria.

True/False

Reason:

[two marks]

8.4 Electron transport produces ATP directly from the transfer of electrons from NADH to O_2.

True/False

Reason:

[two marks]

8.5 In eukaryotic cells, glycolysis occurs in the cytoplasm, whereas the reactions of the citric acid cycle (Krebs' Cycle) and oxidative phosphorylation take place only in the mitochondria.

True/False

Reason:

[two marks]

8.6 During glycolysis and respiration, glucose reacts directly with O_2 to form CO_2 and H_2O.

True/False

Reason:

[two marks]

8.7 Glycolysis occurs under aerobic and anaerobic conditions.

True/False

Reason:

[two marks]

[Total: thirteen marks]

9. This question concerns water potentials in plant cells.

9.1 Briefly describe the process of osmosis in terms of kinetic energy of water molecules.

[two marks]

9.2 Why is it the plasma membrane, rather than the cell wall, which is usually considered the more important factor in movement of water by osmosis?

[one mark]

Define each of the following terms:

9.3 Solute potential.

[one mark]

9.4 Pressure potential.

[one mark]

9.5 Water potential.

[one mark]

9.6 Pressure potential usually has a positive value. Name **ONE** part of a plant where the pressure potential may be negative.

_____

[one mark]

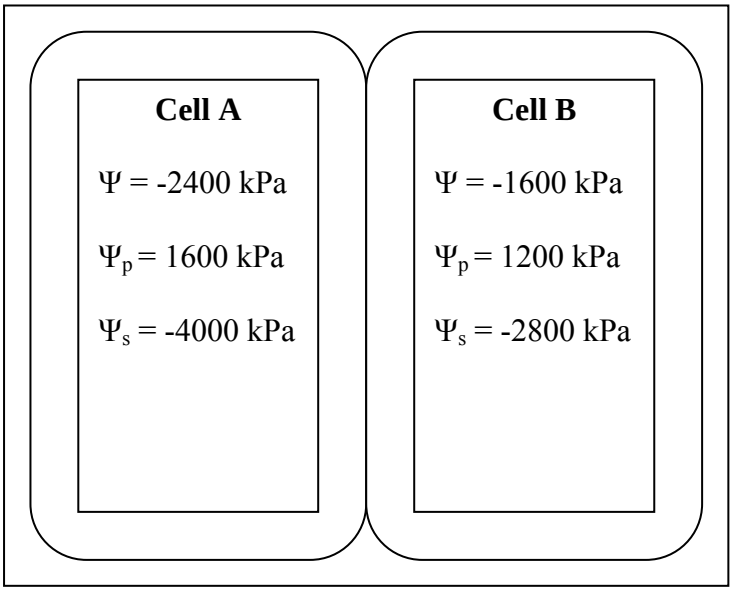

Figure 4

The diagram in **Figure 4** shows two neighbouring plant cells that are in direct contact. The water potential (Ψ), pressure potential (Ψ_p) and solute potential (Ψ_s) are given.

9.7 Which cell has the higher water potential?

_____

[one mark]

9.8 In which direction will water move by osmosis?

_____

[one mark]

9.9 When the system is in equilibrium both cells will have the same water potential (Ψ = -2000 kPa). Assuming that the solute potential will not change significantly, calculate the equilibrium pressure potential in both cells.

_____

_____

[two marks]

[Total: eleven marks]