IB DIPLOMA PROGRAMME
PROGRAMME DU DIPLÔME DU BI
PROGRAMA DEL DIPLOMA DEL BI

M02/410/H(2)+

**BIOLOGY**
**HIGHER LEVEL**
**PAPER 2**

Thursday 9 May 2002 (afternoon)

2 hours 15 minutes

Name

Number

INSTRUCTIONS TO CANDIDATES

- Write your candidate name and number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Section A: Answer all of Section A in the spaces provided.
- Section B: Answer two questions from Section B. Write your answers in a continuation answer booklet, and indicate the number of booklets used in the box below. Write your name and candidate number on the front cover of the continuation answer booklets, and attach them to this question paper using the tag provided.
- At the end of the examination, indicate the numbers of the Section B questions answered in the boxes below.

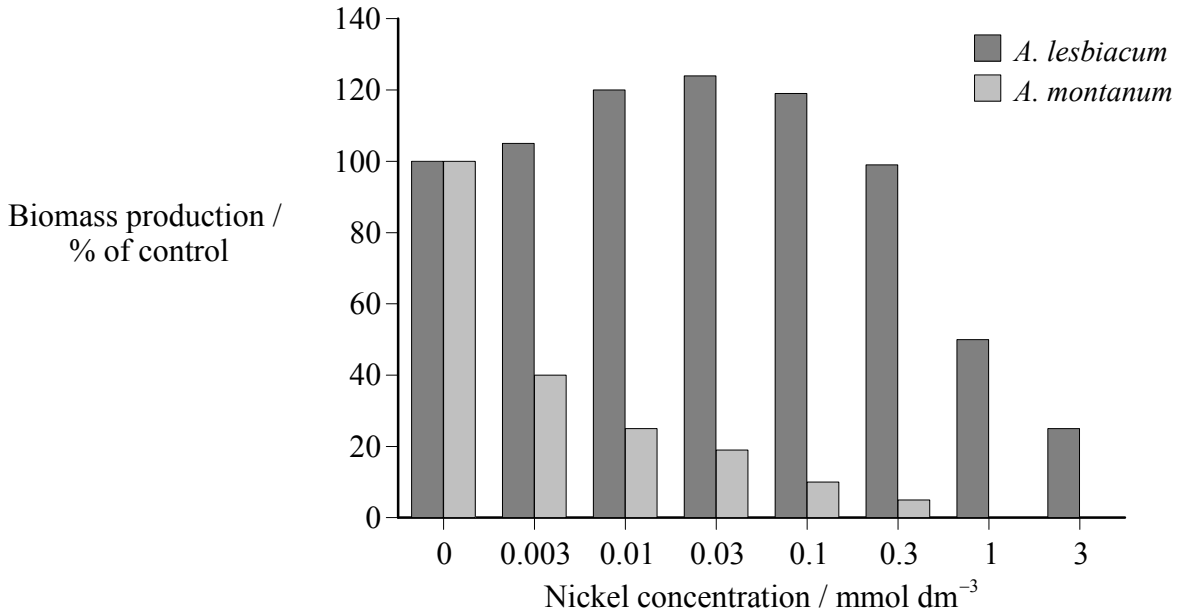
| QUESTIONS ANSWERED | | EXAMINER | TEAM LEADER | IBCA |
|---|---|---|---|---|
| SECTION A | ALL | /32 | /32 | /32 |
| SECTION B | | | | |
| QUESTION | . . . . . | /20 | /20 | /20 |
| QUESTION | . . . . . | /20 | /20 | /20 |
| NUMBER OF CONTINUATION BOOKLETS USED | . . . . . | TOTAL /72 | TOTAL /72 | TOTAL /72 |

## SECTION A

*Candidates must answer **all** questions in the spaces provided.*

**1.** Metals such as zinc, nickel and copper are toxic to most plants. However, some terrestrial plants can store quite a lot of these metal ions in their tissues. These plants are called hyperaccumulators and could be valuable in reducing the levels of such metal ions in the soil.

Some species of *Alyssum* are known to be hyperaccumulators. Two of these *Alyssum* species were grown in nutrient solutions with different concentrations of nickel ions. As a control, each species was grown in nutrient solution which contained no nickel. The following chart shows the biomass production for each species.




[Source: Kramer U, *et al.,* (1996) *Nature,* **379**, page 635]

(a) Identify the nickel concentration at which the biomass production is equal to the control in *A. lesbiacum*. *[1]*

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(b) Compare the effect of nickel concentration on the growth of both species of *Alyssum*. *[3]*

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*(This question continues on the following page)*

*(Question 1 continued)*

(c) Suggest why a nutrient solution was used instead of soil. *[1]*

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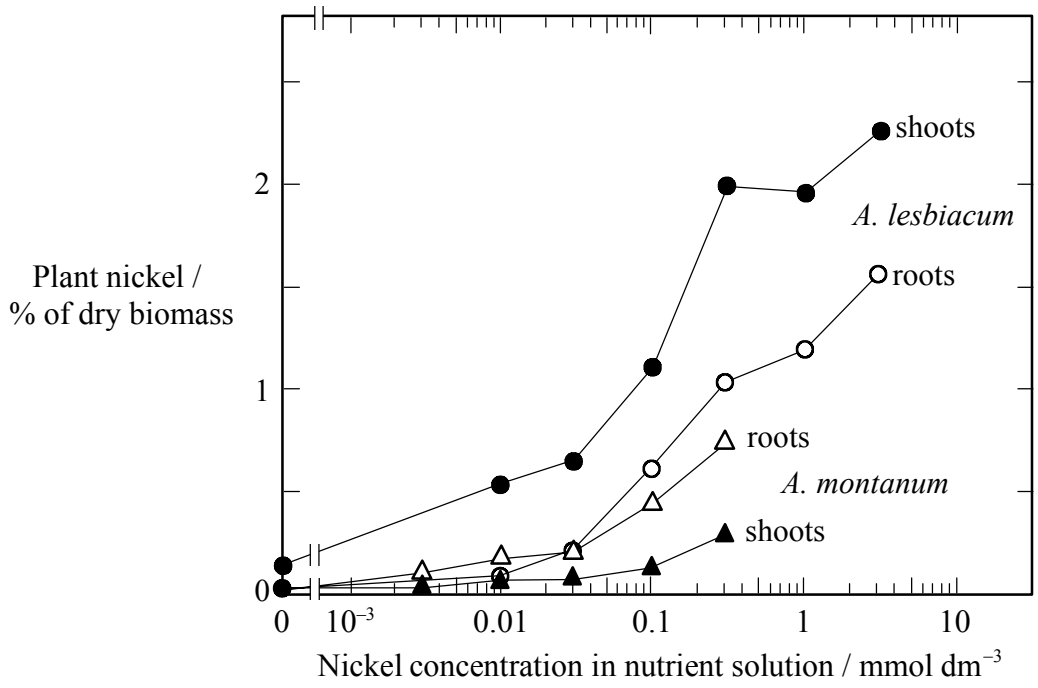
The graph below shows the percentage of nickel in the dry biomass of the shoots and roots of these plants.




[Source: Kramer U, *et al*., (1996) *Nature*, **379**, page 635]

(d) Calculate the change in the percentage of nickel in the dry biomass of *A. lesbiacum* roots when the nickel concentration is increased from 0.1 to 1.0 mmol $dm^{-3}$. *[1]*

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(e) Compare the percentage dry biomass of nickel in the roots and shoots between the two species. *[2]*

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*(This question continues on the following page)*

*(Question 1 continued)*

(f) Suggest a reason for the difference in the percentage dry biomass of nickel in roots and shoots between *A. montanum* and *A. lesbiacum*. *[2]*

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(g) Predict, with an explanation, which species would be most useful in decontaminating soils containing high levels of nickel. *[2]*

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Aquatic environments can be contaminated with pollutants, some of which are organic. An example of this occurred in the Willamette River near Portland, Oregon in the United States. The tissue concentrations of polychlorinated biphenyls (PCB) was measured in three species of fish in two areas of the river. The data are given in parts per billion (ppb).

| | **Concentration of PCB / ppb** | |
|---|---|---|
| | Area 1 | Area 2 |
| *Micropterus sp.* | 42 | 90 |
| *Pomoxis annularis* | 21 | 21 |
| *Cyprinus carpo* | 54 | 41 |

(h) Calculate the mean concentration of PCB found in the tissue of the three species in each area. *[1]*

Area 1: . . . . . .

Area 2: . . . . . .

(i) Compare the amounts of PCB found in *Micropterus sp.* and *C. carpo*. *[2]*

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*(This question continues on the following page)*

*(Question 1 continued)*

(j) The concentration of dissolved PCB in the river is 0.01 ppb. Suggest a reason for the PCB concentration in the three species of fish found in the Willamette River. *[3]*

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**2.** (a) Draw a simple diagram of the gas exchange system in humans. *[3]*

(b) Outline the difference between breathing and cell respiration. *[1]*

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(c) Explain how chemical changes in the blood alter the breathing rate during exercise. *[3]*

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**3.** (a) State the difference between autosomes and sex chromosomes. *[1]*

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(b) State Mendel's second law. *[1]*

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Mendel carried out many crosses of different traits with the common garden pea. Mendel performed dihybrid crosses between the following traits:

- tall and short plants, where the allele for tall (T) is dominant over the allele for short plants (t).
- yellow and green seed coats, where the allele for yellow seed coat (Y) is dominant over the allele for green seed coat (y).

A parental cross of purebred tall plants with a green seed coat was performed with purebred short plants with a yellow seed coat. A self-cross of the $F_1$ generation was made.

(c) Calculate the predicted phenotypic ratio of these unlinked genes in both the $F_1$ and $F_2$ generations. Show your working. *[3]*

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(d) Identify which offspring are recombinants. *[2]*

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## SECTION B

*Answer **two** questions. Up to two additional marks are available for the construction of your answers. Write your answers in a continuation answer booklet. Write your name and candidate number on the front cover of the continuation answer booklets, and attach them to this question paper using the tag provided.*

**4.** (a) Outline the general features used to classify organisms into the kingdoms: Prokaryotae, Protoctista, Fungi, Plantae, and Animalia. *[5]*

(b) Outline a technique for transferring genes between species. *[5]*

(c) Discuss the need to maintain the biodiversity of organisms as a reservoir of alleles. *[8]*

**5.** (a) Draw a diagram to show the distribution of tissues in a cross-section of a root in a dicotyledonous plant. *[5]*

(b) Describe the process of mineral ion uptake into roots. *[5]*

(c) Explain the functions of the different tissues of a leaf. *[8]*

**6.** (a) Draw the structure of a mitochondrion as seen in an electron micrograph. *[5]*

(b) Describe the central role of acetyl (ethanoyl) CoA in carbohydrate and fat metabolism. *[5]*

(c) Discuss the importance of a balanced diet for people with varying energy needs. *[8]*

**7.** (a) Describe the ways in which proteins within the cell are transported to the cell surface. *[4]*

(b) Describe the roles of mRNA, tRNA and ribosomes in translation. *[6]*

(c) Discuss the theory that species evolve by natural selection using **two** named examples. *[8]*