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

M04/412/S(2)+

BIOLOGY
STANDARD LEVEL
PAPER 2

Candidate number

Tuesday 11 May 2004 (afternoon)

1 hour 15 minutes

INSTRUCTIONS TO CANDIDATES

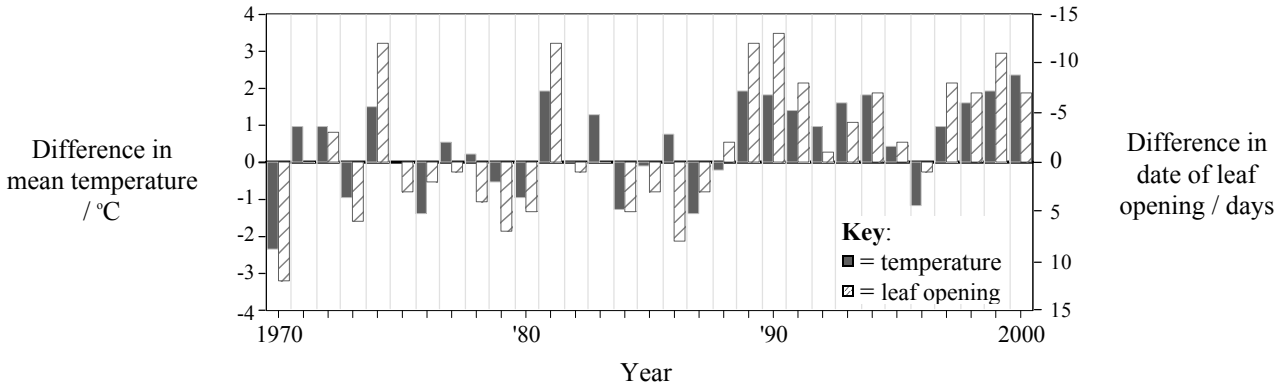
- Write your candidate number in the box above.
- Do not open this examination paper until instructed to do so.
- Section A: answer all of Section A in the spaces provided.
- Section B: answer one question from Section B. Write your answers on answer sheets. Write your candidate number on each answer sheet, and attach them to this examination paper and your cover sheet using the tag provided.
- At the end of the examination, indicate the numbers of the questions answered in the candidate box on your cover sheet and indicate the number of sheets used in the appropriate box on your cover sheet.

SECTION A

Answer all the questions in the spaces provided.

1. Phenologists are biologists who study the timing of seasonal activities in animals and plants, such as the opening of tree leaves and the laying of eggs by birds. Data such as these can provide evidence of climate changes, including global warming.

The date in the spring when new leaves open on horse chestnut trees *(Aesculus hippocastaneum)* has been recorded in Germany every year since 1951. The graph below shows the difference between each year's date of leaf opening and the mean date of leaf opening between 1970 and 2000. Negative values indicate that the date of leaf opening was earlier than the mean. The graph also shows the difference between each year's mean temperature during March and April and the overall mean temperature for these two months. The data for temperature was obtained from the records of thirty-five German climate stations.



[Source: Walther *et al*., *Nature* (2002), **416**, pages 389–395]

(a) Identify the year in which there was the

(i) earliest opening of horse chestnut leaves. *[1]*

. . . . . .

(ii) lowest mean temperature in March and April. *[1]*

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(This question continues on the following page)

(Question 1 continued)

(b) Use the data in the graph to deduce the following.

(i) The relationship between temperatures in March and April and the date of opening of leaves on horse chestnut trees. *[1]*

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(ii) Whether there is evidence of global warming towards the end of the twentieth century. *[2]*

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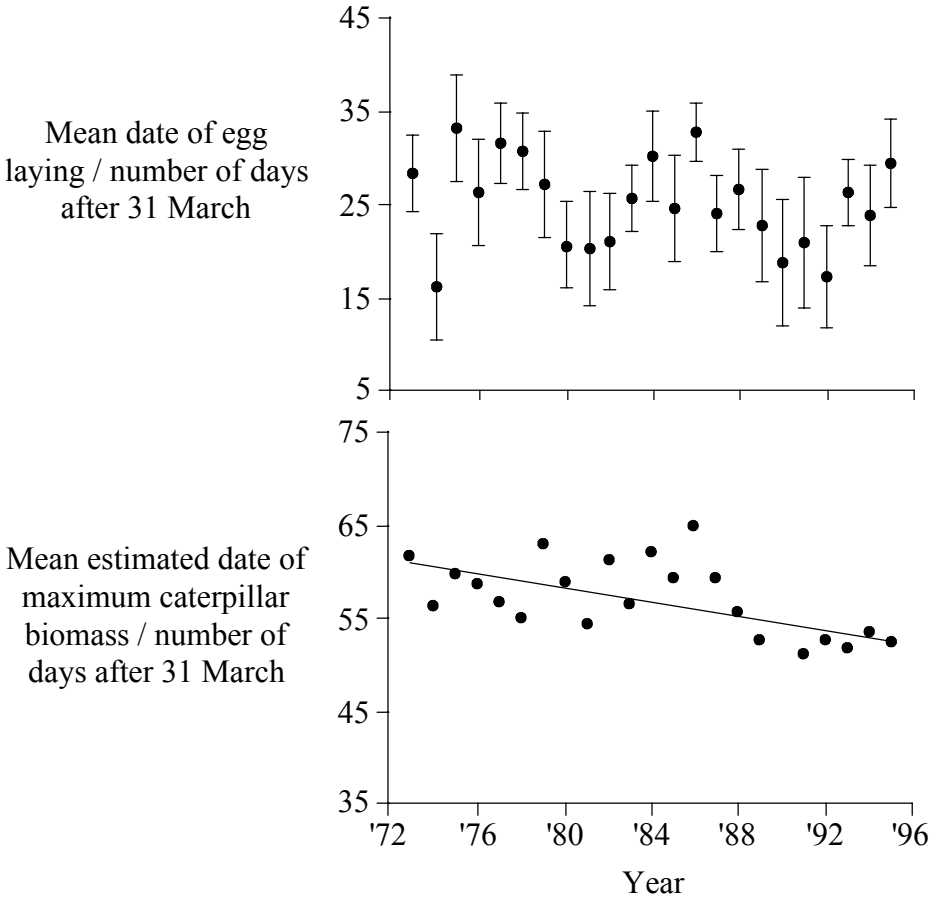
(Question 1 continued)

From 1973 onwards phenologists in the Netherlands have been studying a population of great tits *(Parus major)* in a forest on the Hoge Veluwe. Nest boxes are checked every week to find out when the great tits lay their eggs and how many eggs they lay. Young birds are ringed when they are seven days old, to allow the reproductive success of their parents to be monitored. Great tits feed on arthropods, especially caterpillars. The phenologists found that the date of maximum caterpillar biomass each year in the forest could be estimated accurately using temperature records. The graphs below show the mean date of egg laying and the estimated date of maximum caterpillar biomass for each year from 1973 to 1995.



[Source: Visser, Noordwijk, Tinbergen and Lessells, *Proceedings of the Royal Society of London*, (1998), **265**, pages 1867–1870]

(c) (i) Compare the date of egg laying with the date of maximum caterpillar biomass. *[1]*

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(ii) Suggest an advantage to great tits of the difference in dates. *[1]*

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(This question continues on the following page)

(Question 1 continued)

(d) State the trend, shown in the graph, for the date of maximum caterpillar biomass. *[1]*

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There was no statistically significant change in the date of egg laying between 1973 and 1995, but the phenologists found evidence that natural selection will eventually cause a change in the date of egg laying.

(e) Explain how natural selection could cause a change in the date of egg laying in the population of great tits in the forest on the Hoge Veluwe. *[2]*

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2. (a) An organelle is a discrete structure within a cell with a specific function. In the table below, identify the missing organelles and outline the missing functions. *[4]*

Name of organelle	**Structure of organelle**	**Function of organelle**
Nucleus	Region of the cell containing chromosomes, surrounded by a double membrane, in which there are pores.	Storage and protection of chromosomes
Ribosome	Small spherical structures, consisting of two subunits.	. . . . .
. . . . .	Spherical organelles, surrounded by a single membrane and containing hydrolytic enzymes.	Digestion of structures that are not needed within cells.
. . . . .	Organelles surrounded by two membranes, the inner of which is folded inwards.	. . . . .

(b) The table above shows some of the organelles found in a particular cell. Discuss what type of cell this could be. *[2]*

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3. During photosynthesis in plants, light energy is absorbed by chlorophyll. This energy is then used to carry out photolysis, which supply substances that are needed to convert carbon dioxide into organic molecules such as glucose.

(a) State the names of **two** products of photolysis in photosynthesis. *[2]*

1. . . . . .

2. . . . . .

(b) Explain briefly **one** method for measuring the rate of photosynthesis in a plant. *[2]*

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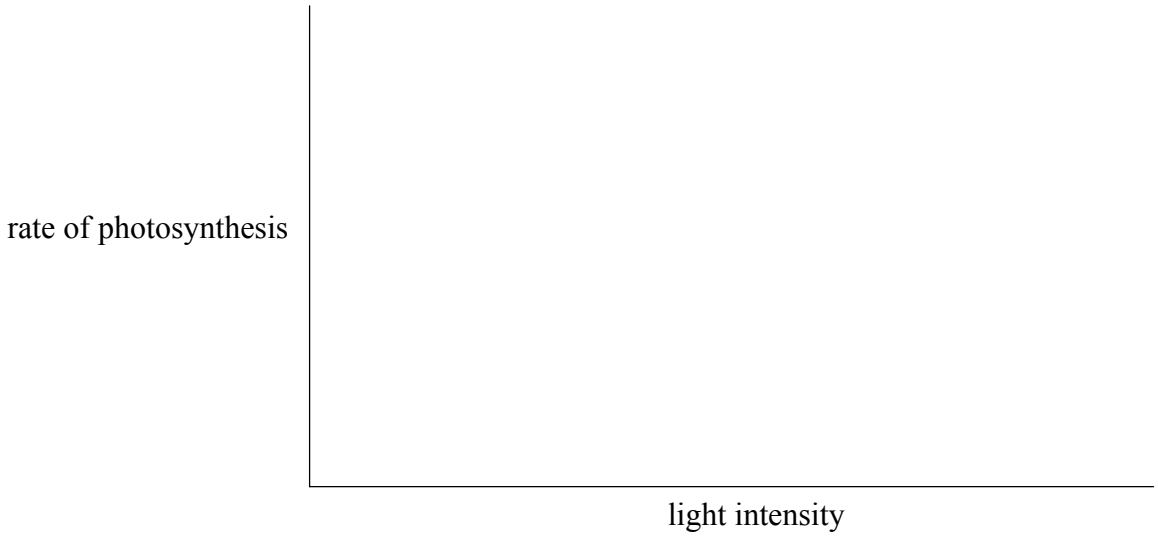
(c) The rate of photosynthesis is affected by light intensity. Draw a line on the graph below to show the relationship between light intensity and the rate of photosynthesis. *[2]*



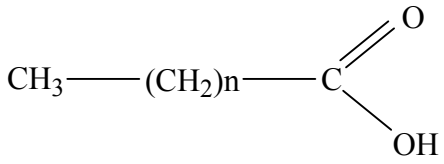
(d) State **two** factors in the environment of a plant, apart from light intensity, that can affect the rate of photosynthesis in the plant. *[2]*

1. . . . . .

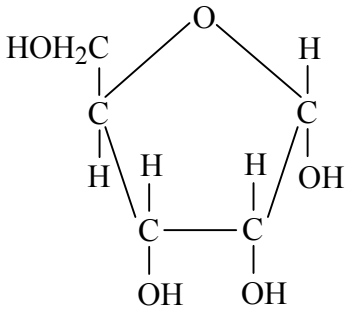
2. . . . . .

4. The diagrams below show various molecular structures.

I.



II.



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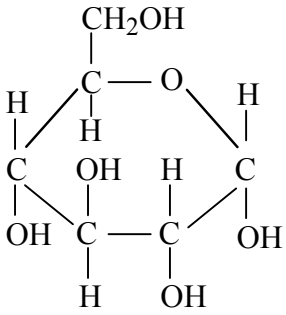
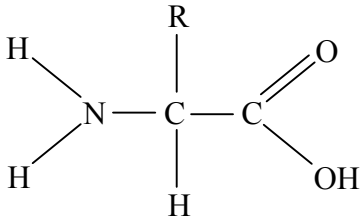


IV.



(a) Identify which of the diagrams represent

(i) the structure of glucose. *[1]*

. . . . . .

(ii) the structure of amino acids. *[1]*

. . . . . .

(iii) the structure of fatty acids. *[1]*

. . . . . .

(b) Discuss which of the molecules are most similar in structure. *[3]*

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SECTION B

*Answer **one** question. Up to two additional marks are available for the construction of your answer. Write your answers on the answer sheets provided. Write your candidate number on each answer sheet, and attach them to this examination paper and your cover sheet using the tag provided.*

5. (a) Sickle cell anemia is a serious disease caused by a single base substitution mutation. Explain how a single base substitution mutation can have significant consequences for an individual. *[6]*

(b) Discuss whether genetic screening should be carried out for sickle cell anemia and other genetic diseases. *[4]*

(c) Outline a method for carrying out gene therapy, using a named example. *[8]*

6. (a) Humans develop secondary sexual characteristics during puberty. Compare the secondary sexual characteristics of males with those of females. *[4]*

(b) Draw a labelled diagram of the reproductive system of a human female. *[6]*

(c) Explain how hormones control the menstrual cycle in human females. *[8]*

7. (a) In communities, groups of populations live together and interact with each other. Outline the importance of plants to populations of other organisms in a community. *[6]*

(b) Describe a method, used by ecologists, for estimating accurately the size of a plant population. *[4]*

(c) Explain the reasons for the sizes of animal populations within communities changing and the reasons for them remaining constant. *[8]*