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

N04/4/BIOLO/HP2/ENG/TZ0/XX

88046002

BIOLOGY
HIGHER LEVEL
PAPER 2

School code

Candidate code

Wednesday 10 November 2004 (afternoon)

2 hours 15 minutes

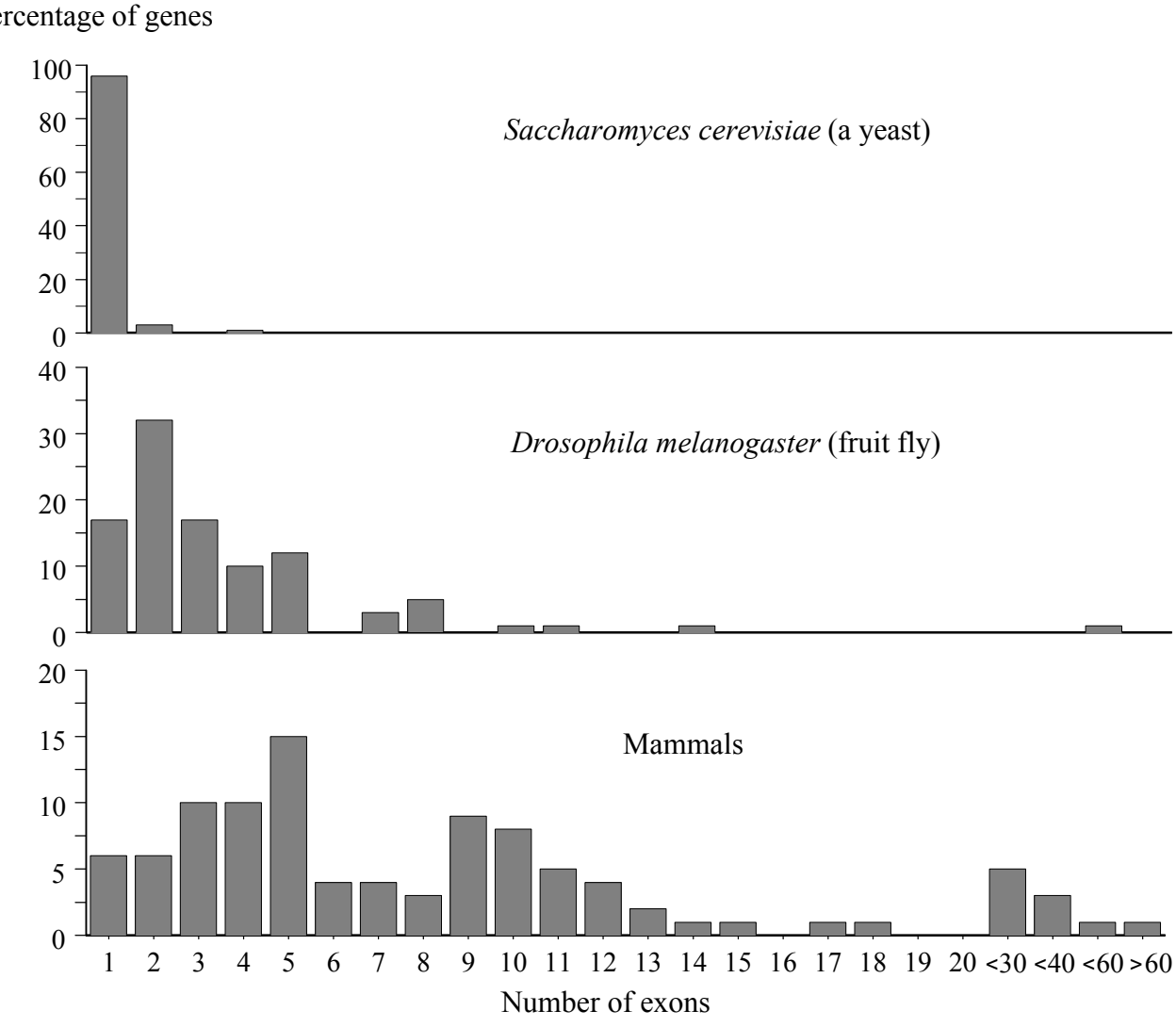
INSTRUCTIONS TO CANDIDATES

- Write your school code and candidate code 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 on answer sheets. Write your school code and candidate code 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. It had always been assumed that eukaryotic genes were similar in organization to prokaryotic genes. However, modern techniques of molecular analysis indicated that there are additional DNA sequences that lie within the coding region of genes. Exons are the DNA sequences that code for proteins while introns are the intervening sequences that have to be removed. The graph shows the number of exons found in genes for three different groups of eukaryotes.



[Source: Benjamin Lewin, (1999), *Genes VII*, OUP, page 55]

(a) Calculate the percentage of genes that have five or less exons in mammals. *[1]*

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(This question continues on the following page)

(Question 1 continued)

(b) Describe the distribution of the number of exons and the percentage of genes in *D. melanogaster*. *[2]*

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(c) (i) Compare the distributions of the number of exons found in genes of *S. cerevisiae* and mammals. *[2]*

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(ii) Suggest **one** reason for the differences in the numbers of exons found in genes of *S. cerevisiae* and mammals. *[1]*

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(Question 1 continued)

Human DNA has been analysed and details of certain genes are shown in the table below.

Gene	Gene size / kb*	mRNA size / kb	Number of introns
Insulin	1.7	0.4	2
Collagen	38.0	5.0	50
Albumin	25.0	2.1	14
Phenylalanine hydroxylase	90.0	2.4	12
Dystrophin	2 000.0	17.0	50

* kilobase pairs

[Source: William S Klug and Michael R Cummings, (2002), *Concepts of Genetics*, 7th edition, Prentice Hall, page 314]

(d) Calculate the average size of the introns for the albumin gene. *[2]*

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(e) Analyse the relationship between gene size and the number of introns. *[2]*

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(f) Determine the maximum number of amino acids that could be produced by translating the phenylalanine hydroxylase mRNA. *[1]*

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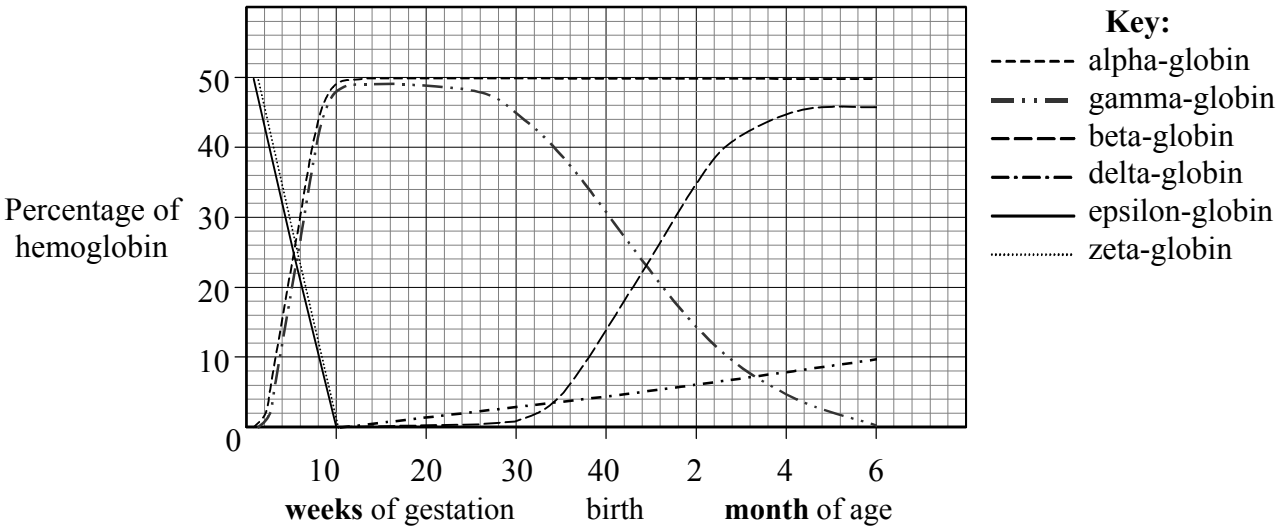
(Question 1 continued)

Hemoglobin is a protein composed of two pairs of globin molecules. During the process of development from conception to adulthood, human hemoglobin changes in composition. Adult hemoglobin consists of two alpha- and two beta-globin molecules. Two globin genes occur on chromosome 16: alpha- and zeta-globin. Four other globin genes are found on chromosome 11: beta, delta, epsilon and gamma. The graph below illustrates the changes in expression of the globin genes over time.



[Source: adapted from M Cummings, *Human Heredity*, 4th edition, West/Wadsworth Publishing Company]

(g) State which globin genes are the first to be expressed after fertilization. *[1]*

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(h) Compare the expression of the gamma-globin gene with the beta-globin gene. *[3]*

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(i) Deduce the composition of the hemoglobin molecules *[2]*

at 10 weeks of gestation. . . . . .

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2 months after birth. . . . . .

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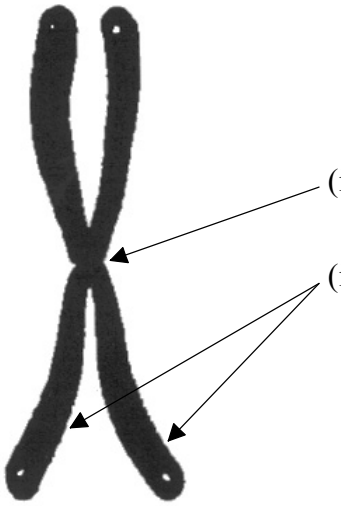
2. (a) State the names of the parts of the chromosome labelled (i) and (ii) on the diagram below. *[2]*



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[Source: adapted from L Hartwell (editor) (2003), *Genetics: from Genes to Genomes*, 2nd edition, McGraw Hill, page 81]

(b) Explain how the inheritance of chromosome 21 can lead to Down's syndrome. *[3]*

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(c) Explain how meiosis promotes variation in a species. *[2]*

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3. (a) Draw a labelled diagram of a nephron. *[3]*

(b) Explain the process of ultrafiltration in the kidney. *[3]*

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(c) Compare the composition of blood plasma in the renal artery with the composition of the glomerular filtrate. *[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 on the answer sheets provided. Write your school code and candidate code on each answer sheet, and attach them to this examination paper and your cover sheet using the tag provided.*

4. (a) Outline the significance to organisms of the different properties of water. *[5]*

(b) Describe the process of active transport across membranes. *[5]*

(c) Explain the principles of synaptic transmission. *[8]*

5. (a) Draw a labelled diagram of a mature sperm. *[3]*

(b) Describe the structure and function of the placenta. *[6]*

(c) Explain the control of blood glucose levels in a human. *[9]*

6. (a) Compare the structure of bryophytes and angiospermophytes. *[5]*

(b) Explain how the abiotic factors of light, wind and humidity affect the rate of transpiration. *[8]*

(c) Describe the metabolic events of germination in a typical starchy seed. *[5]*

7. (a) Describe the cause, transmission and effects of **one** named bacterial disease. *[5]*

(b) Discuss the benefits and dangers of vaccination. *[8]*

(c) Outline a basic technique for gene transfer involving plasmids. *[5]*