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BIOLOGY
STANDARD LEVEL
PAPER 2

Candidate session number

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Wednesday 18 May 2011 (afternoon)

1 hour 15 minutes

Examination code

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INSTRUCTIONS TO CANDIDATES

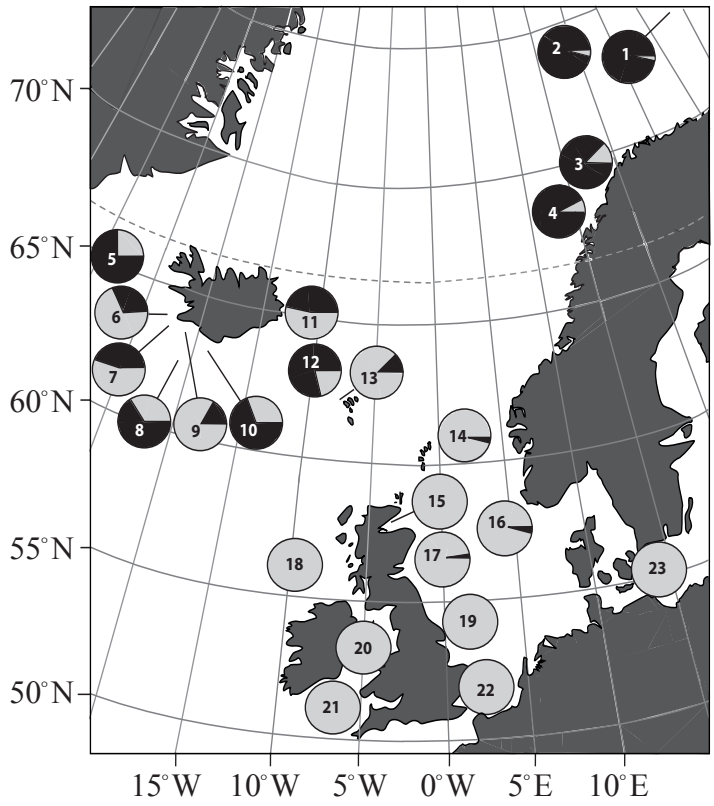
- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Section A: answer all questions.
- Section B: answer one question.
- Write your answers in the boxes provided.

16 pages

SECTION A

*Answer **all** questions. Write your answers in the boxes provided.*

1. *Pan*I is a gene in cod fish that codes for an integral membrane protein called pantophysin. Two alleles of the gene, *Pan*I^{A} and *Pan*I^{B}, code for versions of pantophysin, that differ by four amino acids in one region of the protein. Samples of cod fish were collected from 23 locations in the north Atlantic and were tested to find the proportions of *Pan*I^{A} and *Pan*I^{B} alleles in each population. The results are shown in pie charts, numbered 1–23, on the map below. The proportions of alleles in a population are called the allele frequencies. The frequency of an allele can vary from 0.0 to 1.0. The light grey sectors of the pie charts show the allele frequency of *Pan*I^{A} and the black sectors show the allele frequency of *Pan*I^{B}.



RAJ Case et al "Macro- and micro-geographic variation in pantophysin (PanI) allele frequencies in NE Atlantic cod Gadus morhua" MEPS 301: 267–278 (2005). Figs 1 and 3.

(This question continues on the following page)

(Question 1 continued)

(a) (i) State the **two** populations with the highest *Pan*I^B allele frequencies. *[1]*

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(ii) State the population in which the allele frequencies were closest to 0.5. *[1]*

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(b) Deduce the allele frequencies of a population in which half of the cod fish had the genotype *Pan*I^A *Pan*I^A, and half had the genotype *Pan*I^A *Pan*I^B. *[1]*

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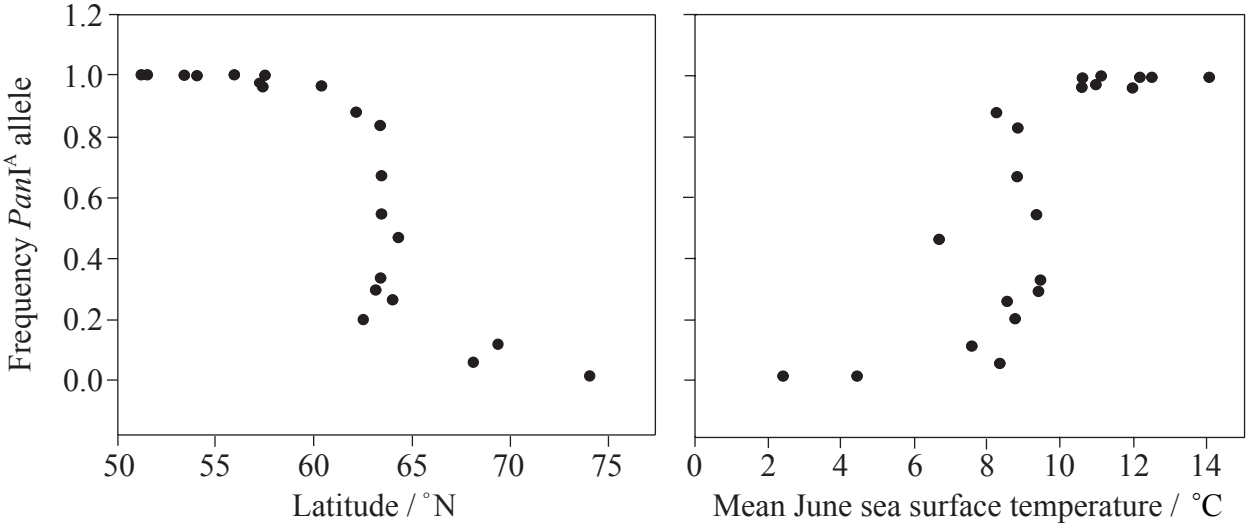
(Question 1 continued)

The graphs below show the latitude and the mean surface sea temperature in June of the sampling locations and the frequency of the *Pan*I^{A} allele.



RAJ Case et al "Macro- and micro-geographic variation in pantophysin (PanI) allele frequencies in NE Atlantic cod Gadus morhua" MEPS 301: 267–278 (2005). Figs 1 and 3.

(c) State the relationship between

(i) latitude and the frequency of the *Pan*I^{A} allele. *[1]*

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(ii) mean surface sea temperature in June and the frequency of the *Pan*I^{A} allele. *[1]*

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(Question 1 continued)

(d) Suggest how natural selection could have caused the relationships shown in the graphs. *[2]*

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(e) The sites close to Iceland, at a latitude of 60–65°, had very varied allele frequencies, with both *Pan*I^A and *Pan*I^B occurring. The water at these sample sites was highly stratified, with much warmer water at the surface and much colder water below. Suggest reasons for both *Pan*I^A and *Pan*I^B alleles occurring at these sites. *[2]*

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(f) Using the data in this question, predict the effects of global warming on cod fish populations. *[2]*

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2. (a) State the missing source, optimum pH requirement, substrate and product of the human enzymes in the table below. *[2]*

Enzyme	Source	Optimum pH	Substrate	Products
Amylase	Salivary gland	7		
Lipase			Lipids	Fatty acids and glycerol

(b) Explain the need for enzymes in digestion. *[2]*

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(c) Draw a labelled diagram to show the interconnections between the gall bladder, pancreas and small intestine. *[3]*

3. (a) State the name of the technique that is used to separate fragments of DNA according to their size, during DNA profiling. *[1]*

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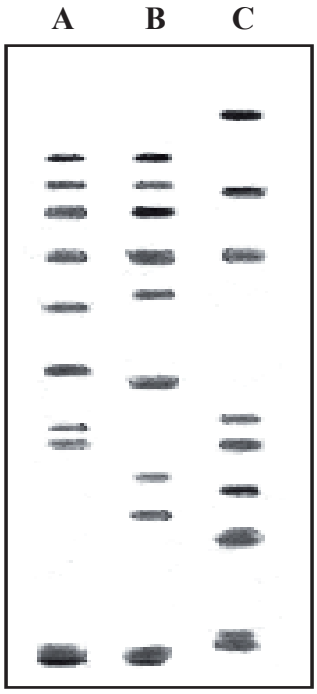
(b) The diagram below represents the results of a paternity investigation. Track A is the profile of the mother of a child, track B is the profile of the child and track C is the profile of a man who might be the father.



Explain, using evidence from the diagram, whether this man is the father or not. *[3]*

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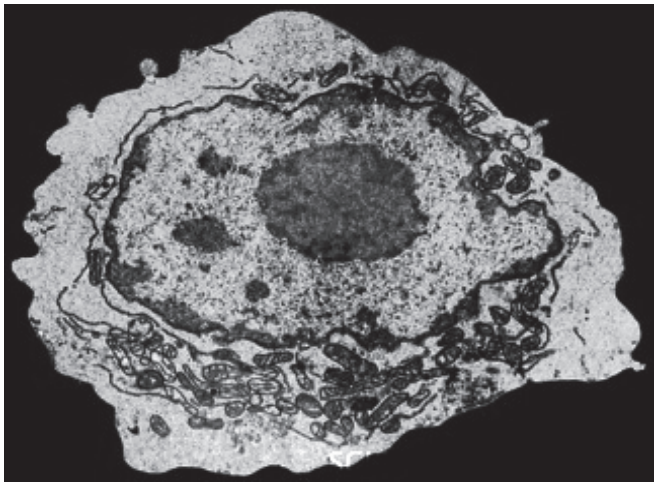
4. The micrograph below shows an adult human stem cell.



(a) The cell cycle can be divided into two parts: interphase and mitosis.

(i) Identify, with a reason, whether the stem cell in the micrograph is in interphase or mitosis. *[1]*

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(ii) Deduce **two** processes that occur in human cells during this part of the cell cycle, but not during the other part. *[2]*

1. . . . . .

2. . . . . .

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(Question 4 continued)

(b) State **two** characteristics of stem cells that can be used to distinguish them from other body cells. *[2]*

1. . . . . .

2. . . . . .

(c) Outline **one** therapeutic use of stem cells. *[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 in the boxes provided.*

5. (a) Living organisms at every trophic level are part of the carbon cycle. Draw a labelled diagram of the carbon cycle to show the processes involved. *[9]*

(b) Explain, using an example of a food chain, how trophic levels can be deduced. *[4]*

(c) Explain methods that can be used to measure the rate of photosynthesis. *[5]*

6. (a) Embryos that are produced by *in vitro* fertilization can be screened for genetic disease. Outline the process of *in vitro* fertilization, including **one** example of a situation when it is used. *[9]*

(b) Explain, using an example, how females but not males can be carriers of some recessive alleles. *[4]*

(c) Explain the causes and consequences of sickle-cell anemia. *[5]*

7. (a) *Escherichia coli* is a unicellular organism, so each cell must carry out all of the processes required for life. Outline the functions of each of the structures in the cells of *Escherichia coli.* *[9]*

(b) Compare the use of carbohydrates and lipids in energy storage. *[4]*

(c) Compare how pyruvate is used in human cells when oxygen is available and when oxygen is not available. *[5]*

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