UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education
Advanced Subsidiary Level and Advanced Level

CANDIDATE NAME	
CENTRE NUMBER	
CANDIDATE NUMBER	

BIOLOGY **9700/21**

Paper 2 Structured Questions AS **October/November 2013**

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name in the spaces provided at the top of this page.
Write in dark blue or black ink.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

This document consists of **15** printed pages and **1** blank page.

Answer **all** the questions.

For Examiner's Use

1 Fig. 1.1 shows a cell of a female fruit fly, *Drosophila melanogaster*, during a stage of mitosis.

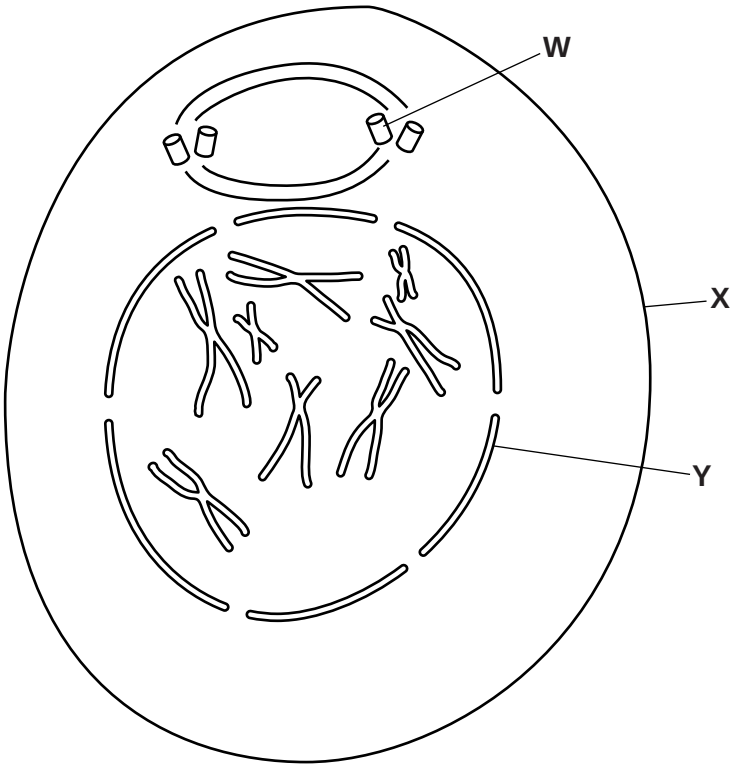

Fig. 1.1

(a) (i) Name the stage of mitosis shown in Fig. 1.1.

.....[1]

(ii) Shade a pair of homologous chromosomes. [1]

(iii) Name the structure labelled **W** and state its function.

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.....[2]

(b) State what happens to structure **X** and to structure **Y** between the stage shown in Fig. 1.1 and the end of cell division.

For Examiner's Use

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[Total: 7]

2 **(a)** Table 2.1 shows eight ions that are biologically important.

Table 2.1

ammonium (NH_4^+)	**A**
hydrogen (H^+)	**B**
hydrogen carbonate (HCO_3^-)	**C**
iron (Fe^{2+})	**D**
magnesium (Mg^{2+})	**E**
nitrate (NO_3^-)	**F**
phosphate (PO_4^{3-})	**G**
sulfate (SO_4^{2-})	**H**

Choose one ion to match each of the following statements. In each case write **one** letter from Table 2.1. You may use each letter (**A** to **H**) once, more than once or not at all.

(i) A component of polynucleotides.

.....[1]

(ii) Ion produced by enzyme activity inside red blood cells.

.....[1]

(iii) Ion used in the production of all amino acids in chloroplasts.

.....[1]

(iv) Ion that diffuses through carrier proteins with sucrose into companion cells in phloem tissue.

.....[1]

(v) Component of haem group in haemoglobin that binds oxygen.

.....[1]

(b) The enzyme nitrogenase is found in free-living and symbiotic nitrogen-fixing bacteria. Nitrogenase catalyses the reaction:

For Examiner's Use

$$N_{2\,(g)} + 6\,e^- + 8H^+_{(aq)} \longrightarrow 2NH_4{}^+_{(aq)}$$

Some nitrogenase enzymes have vanadium ions in their active sites; others have molybdenum ions.

Explain how the enzyme nitrogenase functions in the fixation of nitrogen.

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(c) Some pea plants were grown with their roots in a solution of mineral ions. The solution was kept aerated for three days.
The concentrations of five ions in the solution and in the root tissue were determined after the three days. The results are shown in Table 2.2.

Table 2.2

ion	concentration / mmol dm^{-3}	
	surrounding solution	**root tissue**
potassium (K^+)	1.0	75.0
magnesium (Mg^{2+})	0.3	3.5
calcium (Ca^{2+})	1.0	2.0
phosphate (PO_4^{3-})	1.0	21.1
sulfate (SO_4^{2-})	0.3	19.7

With reference to Table 2.2, suggest how cell surface membranes of root cells are responsible for the concentrations of ions in the roots compared to the surrounding solution.

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[Total: 14]

Question 3 starts on page 8

3 **(a)** Tuberculosis (TB) and chronic obstructive pulmonary disease (COPD) are diseases that affect the lungs.

With reference to TB and COPD, explain how infectious diseases differ from non-infectious diseases.

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Macrophages are large phagocytic cells that are found in many tissues including alveolar tissue in the lungs. They provide the main means of defence against pathogens in this tissue.

Fig. 3.1 is a drawing made from an electron micrograph showing part of a capillary and two alveoli, with a macrophage.

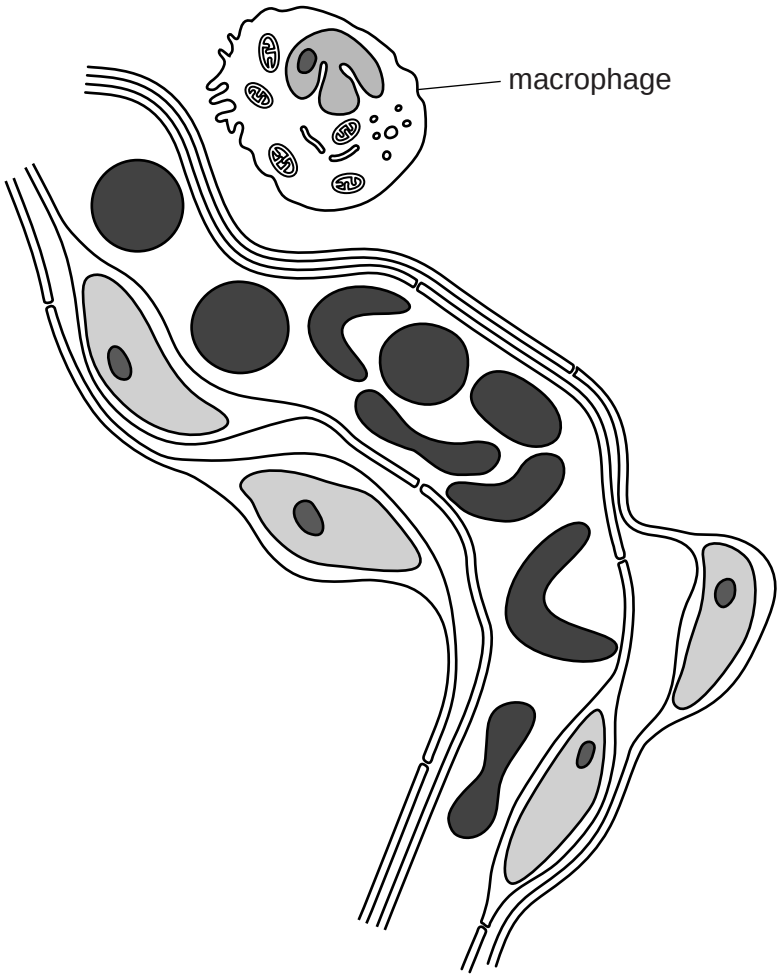

Fig. 3.1

(b) With reference to Fig. 3.1, explain:

For Examiner's Use

(i) how alveoli are adapted for gaseous exchange

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.....[3]

(ii) how macrophages function to protect the lungs from becoming infected.

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(c) Phagocytes release enzymes that digest proteins. In smokers, this may lead to the large-scale destruction of alveolar walls.

Outline the effects of this destruction on a person's health.

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[Total: 12]

4 Cholesterol is synthesised in the smooth endoplasmic reticulum (SER) in liver cells by a series of enzyme-catalysed reactions.

For Examiner's Use

Within the SER, molecules of cholesterol and triglycerides are surrounded by proteins and phospholipids to form lipoproteins. These lipoprotein particles enter the Golgi apparatus where they are packaged into vesicles and pass to the blood.

Fig. 4.1 is an electron micrograph of part of a liver cell showing lipoprotein particles within the Golgi apparatus.

Fig. 4.1

(a) Name structure **T** in Fig. 4.1 and state its role in liver cells.

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(b) **(i)** Suggest why cholesterol is packaged into lipoproteins before release from liver cells into the blood.

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(ii) Explain why cells of the body need to be supplied with cholesterol.

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(c) Cholesterol is also packaged into vesicles by the SER and then secreted from the cell into small fluid-filled spaces between the liver cells. These spaces form ducts that drain into the gall bladder to form bile.

Suggest how cholesterol is secreted into ducts, such as the duct in Fig. 4.1.

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(d) State **one** function of the Golgi apparatus **other than** the packaging of substances into vesicles for transport.

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[Total: 9]

[Turn over

5 Table 5.1 shows the triplets of bases on the template polynucleotide of DNA for some amino acids.

For Examiner's Use

Table 5.1

amino acid		DNA triplets
glutamic acid	(glu)	CTT CTC
histidine	(his)	GTA GTG
leucine	(leu)	GAA GAG GAT GAC
proline	(pro)	GGA GGG GGT GGC
threonine	(thr)	TGA TGG TGT TGC
valine	(val)	CAA CAG CAT CAC

Fig. 5.1 shows the base sequences in DNA and mRNA for the first seven amino acids of the β chain of haemoglobin.

DNA	CAC	.....	GAC	TGA	GGA	CTC	CTC
mRNA	GUG	CAC	CUG	.....	CCU	GAG	GAG
β chain	val	his	.....	thr	pro	glu	glu

Fig. 5.1

(a) (i) Use Table 5.1 to complete Fig. 5.1. [3]

(ii) State the term used to describe the sequence of amino acids in a polypeptide.

.....[1]

(b) In sickle cell anaemia, the amino acid at position 6 in the β chain is valine and not glutamic acid.

For Examiner's Use

Explain how a single change in the DNA triplet for the sixth amino acid of the gene coding for the β chain leads to the production of a different amino acid sequence.

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[Total: 9]

6 In some ecosystems, certain species fulfil important roles in maintaining biodiversity in communities. These species are often known as keystone species.

For Examiner's Use

The sea otter, *Enhydra lutris*, is found in waters of the northern and eastern coasts of the Pacific, where it occupies a niche as a predator. These coastal waters are rich in kelp communities. Kelp are very large seaweeds that form 'underwater forests'.

In the 19th century the sea otter was hunted for its fur, with the result that populations decreased. A consequence of this reduction in numbers was the disappearance of much of the kelp. Conservation measures in the 20th century restored the numbers of sea otters.

Fig. 6.1 shows the food web for this ecosystem.

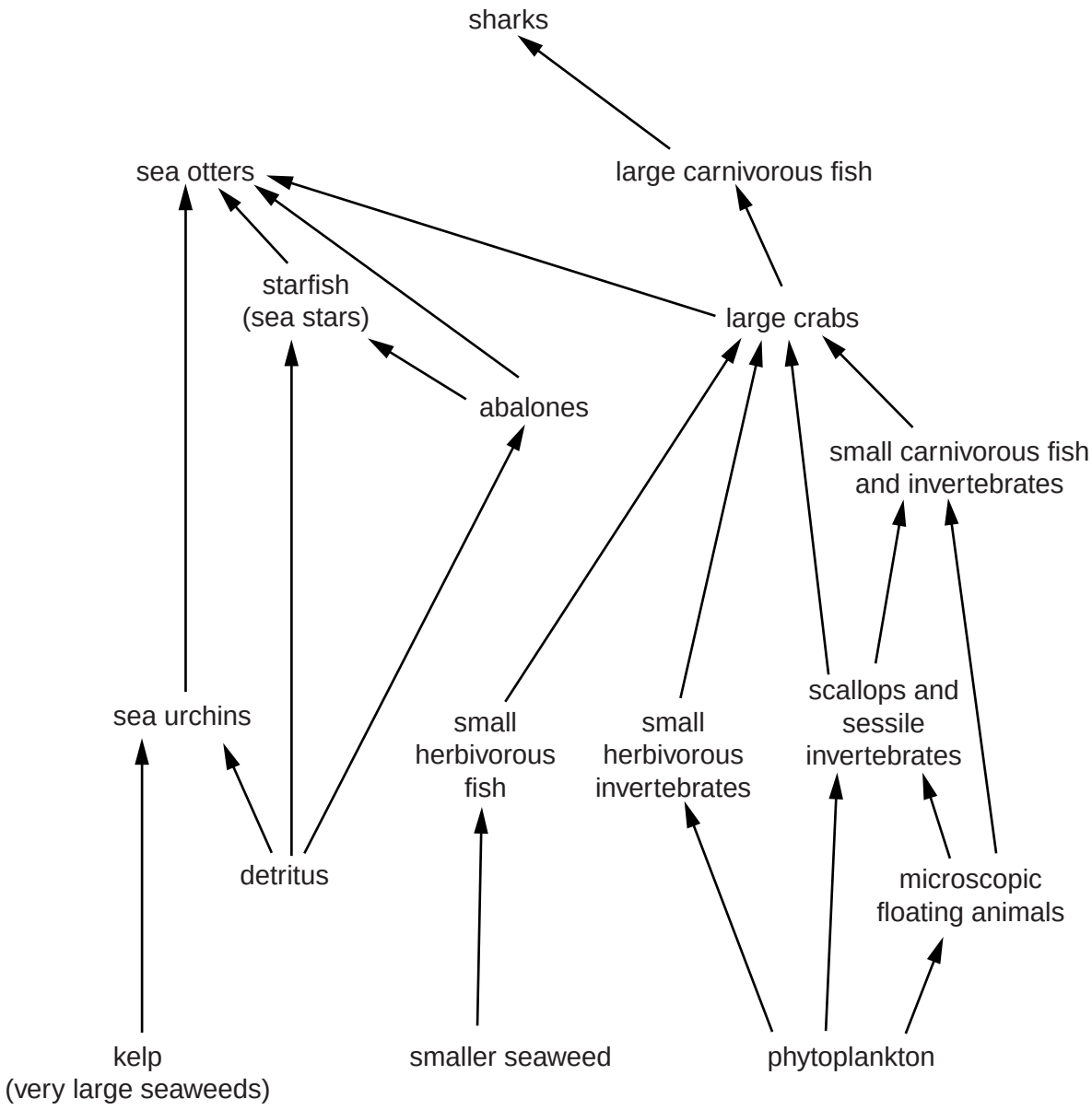

Fig. 6.1

(a) Explain the meaning of the terms *niche* and *community*.

For Examiner's Use

niche .....

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community .....

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(b) With reference to the food web in Fig. 6.1, suggest why sea otters are considered to be a keystone species.

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(c) Suggest how the efficiency of energy transfer from kelp to sea urchins could be determined.

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[Total: 9]

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