Cambridge Pre-U Specimen Papers
and Mark Schemes

Cambridge
Pre-U

Cambridge International Level 3
Pre-U Certificate in
BIOLOGY

For use from 2008 onwards

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Cambridge Pre-U

Specimen Materials

Biology (9790)

Cambridge International Level 3
Pre-U Certificate in Biology (Principal)

For use from 2008 onwards

QAN 500/3807/2

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UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
Cambridge International Level 3 Pre-U Certificate
Principal Subject

BIOLOGY **9790/01**

Paper 1 Multiple Choice **For Examination from 2010**

SPECIMEN PAPER

1 hour 15 minutes

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, Centre number and candidate number on the answer sheet in the spaces provided unless this has been done for you.

There are forty questions on this paper. Answer **all** questions in both **Section A** and **Section B**. For each question there are four possible answers **A**, **B**, **C**, and **D**.
Choose the **one** you consider correct and record your choice in soft pencil on the separate answer sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.

This document consists of **23** printed pages and **1** blank page.

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Section A

1 In the Miller-Urey experiment, complex organic molecules were shown to form under conditions like those that were thought to exist on the early Earth.

Which describes the conditions used in the Miller-Urey experiment?

A inoculated containers with water, methane, ammonia, hydrogen

B inoculated containers with water, ammonia, oxygen, carbon dioxide

C sterile containers with water, methane, ammonia, hydrogen

D sterile containers with water, ammonia, oxygen, carbon dioxide

2 Collagen is a fibrous protein found in mammalian tendons. Which feature contributes most to the great tensile strength of collagen?

A a quaternary structure of triple helices bonded together with covalent and hydrogen bonds

B a secondary structure with many hydrogen bonds firmly holding α-helices

C a regularly folded tertiary structure held together with hydrogen bonds and ionic bonds

D a primary sequence with covalent bonds linking a variable sequence of amino acids

3 Proteins have many varied features. During chemiosmosis, the protein cytochrome c donates four electrons to cytochrome c oxidase enzyme that in turn transfers them to two water molecules as they form.

Which feature is true of both this cytochrome and its oxidase, enabling them to carry out this electron transfer function?

A they are membrane-bound to the inner membrane of the nucleus

B they are extraordinarily thermostable

C they have prosthetic haem groups

D ATP is used in transferring the electrons between them

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4 The enzyme phosphofructokinase is involved in phosphorylation of hexose phosphate sugars during glycolysis. It is involved in control of the rate of glycolysis and thus respiration, by end-product inhibition.

Deduce which of the following is a description of this enzyme.

	shape of binding site(s)	substrate	products
A	no allosteric site, active site complementary to ATP and hexose	hexose	hexose phosphate
B	allosteric site complementary to glucose, active site complementary to hexose phosphate	hexose phosphate	hexose phosphate
C	allosteric site complementary to ATP, active site complementary to ATP and hexose phosphate	hexose phosphate	hexose bisphosphate
D	no allosteric site, active site complementary to hexose bisphosphate	hexose bisphosphate	two triose phosphate

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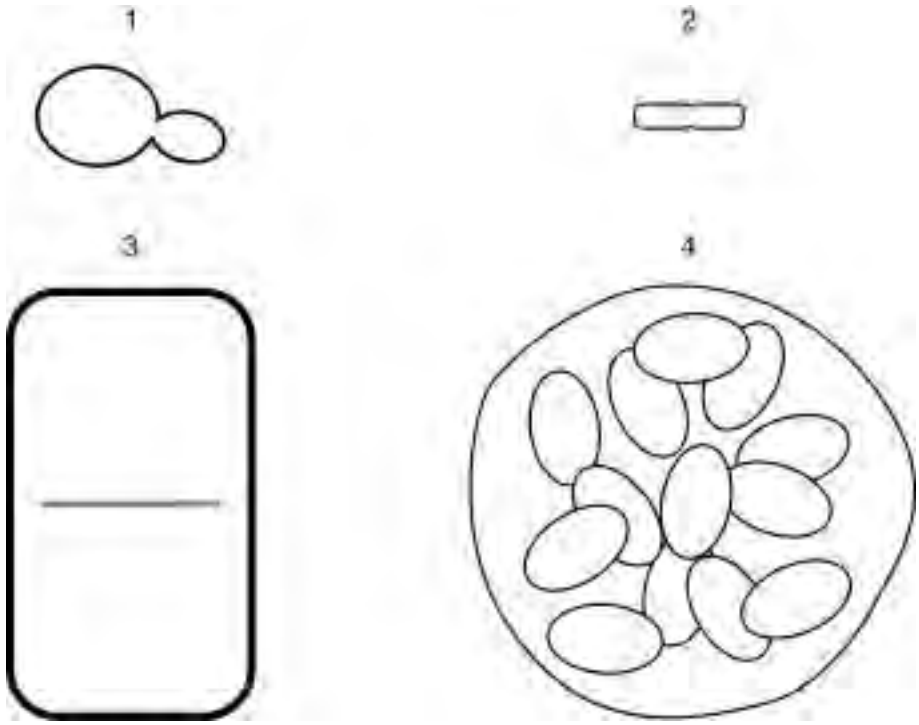
5 The diagram represents the outline of four organisms drawn to the same scale. Each organism is in the process of asexual reproduction.



Deduce the correct kind of kingdom and cell division for each asexually reproducing organism.

	1	2	3	4
A	fungi budding	prokaryotae binary fission	plantae mitosis	protoctista multiple fission
B	protoctista mitosis	plantae mitosis	protoctista mitosis	animalia mitosis
C	prokaryotae binary fission	prokaryotae binary fission	prokaryotae binary fission	animalia meiosis
D	fungi budding	protoctista mitosis	plantae meiosis	protoctista multiple fission

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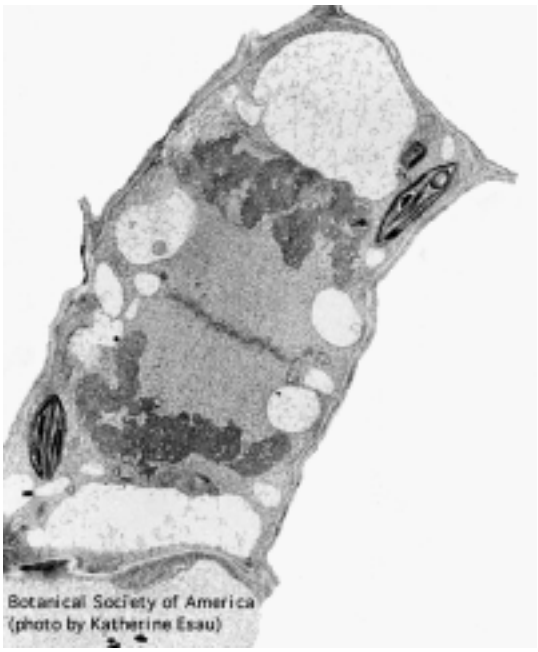
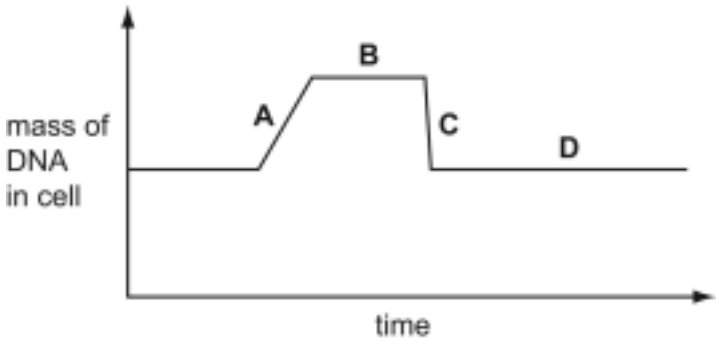
6 The electronmicrograph shows a cell at a particular stage during the cell cycle.



The graph shows the mass of DNA within a cell during the cell cycle.

When does the stage shown in the diagram occur?



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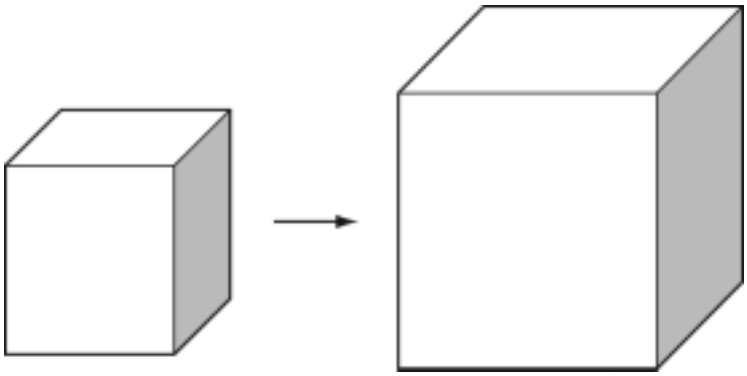
7 The plant leaf cell shown is cubic in shape and has sides 10 μm long. The cell grows until its sides are 20 μm long.



Which is a correct description of the impact of this growth?

	surface area : volume ratio of cell before growth	surface area : volume ratio of cell after growth	impact of growth on rate of uptake of oxygen for photosynthesis per μg of cell mass
A	0.6	0.3	decreased rate of uptake
B	0.6	0.3	increased rate of uptake
C	1.7	3.3	decreased rate of uptake
D	1.7	3.3	increased rate of uptake

8 Which of the following describes a specimen which could be accepted, on the evidence given, as a fossil of a multicellular eukaryote?

	age / millions of years	organic remains	nature of specimen
A	1200–1300	hopanes	'worm-holes' 10 mm wide, too large to be consistent with single-celled organisms
B	1900–2100	absent	many-layered sediment with isolated rounded structures of 1 μm diameter
C	325–350	absent	transparent hexagonal rods with no visible internal structure, up to 40 mm long, on rock
D	600–650	steranes	an ellipse 20 mm long with 6 visible segments, embedded in a large slab of rock

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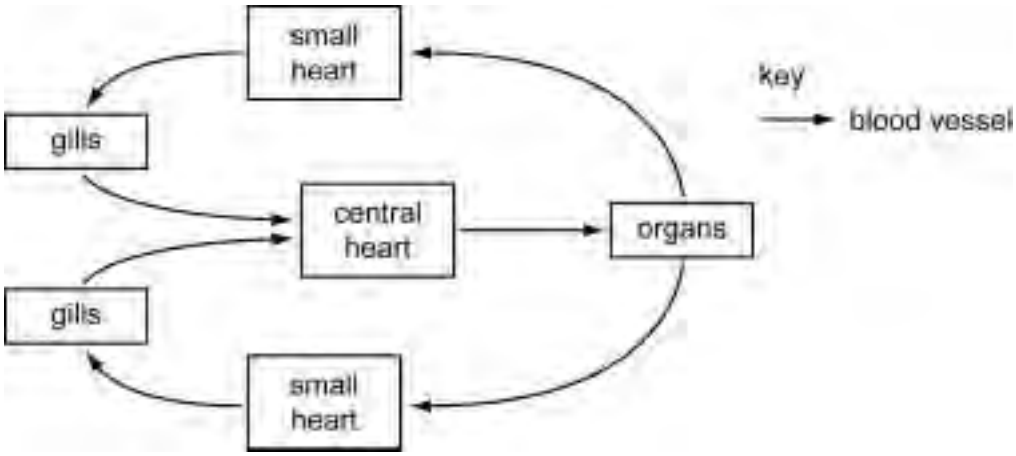
9 The circulatory system of a squid is shown in the diagram below.



From your experience of the circulatory systems of other organisms, deduce which is the best description of the squid circulatory system.

A driven by energy released by respiration, closed double circulatory system

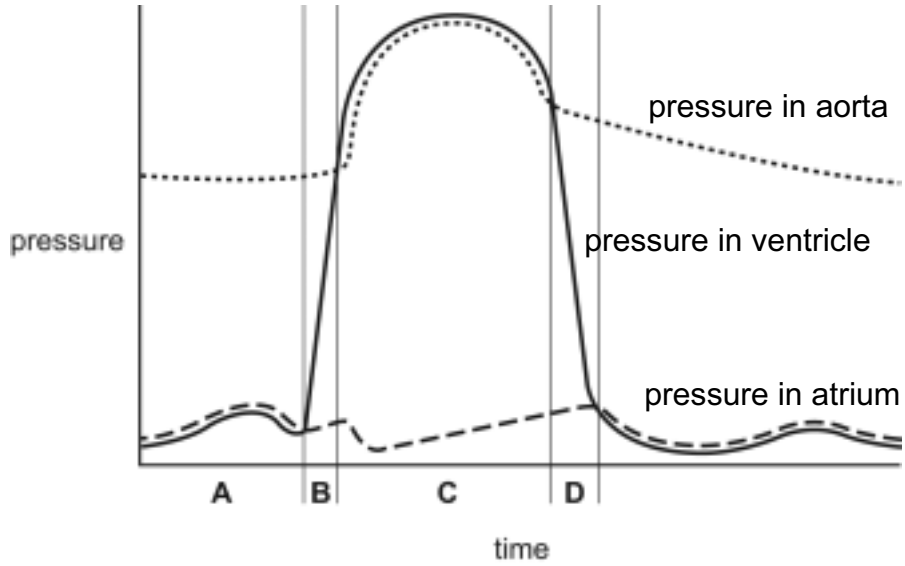
B driven by energy released by respiration, open single circulatory system

C driven by energy released from evaporation, closed single circulatory system

D driven by energy released from evaporation, open double circulatory system

10 The diagram shows the pressure changes during a cardiac cycle in the left side of a human heart.

When is blood being pumped out of the heart?



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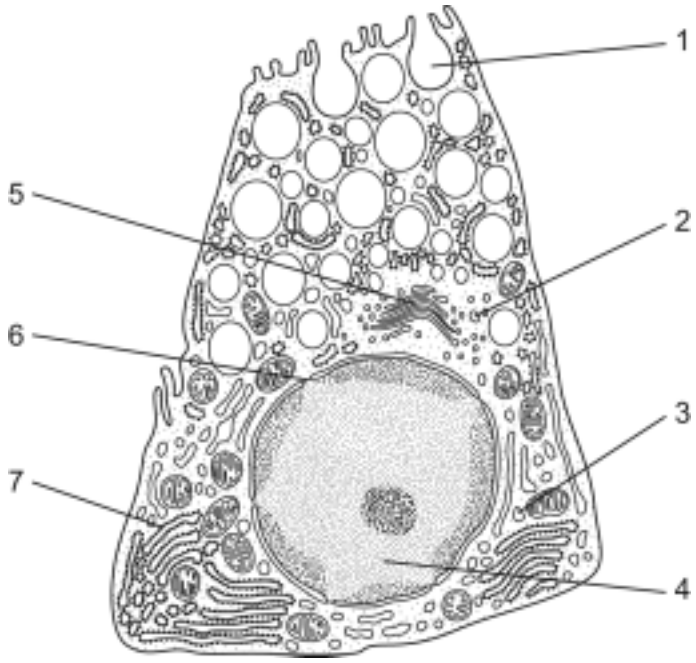
11 The diagram shows a secretory cell from a mammalian alimentary canal. In this cell, a gene is being transcribed and translated to yield a polypeptide that is then folded, activated and secreted, forming a digestive enzyme.



Which of the following shows the most likely sequence of locations involved in this process?

	start →						finish
A	6	3	4	7	2	5	1
B	6	4	3	7	5	2	1
C	4	6	7	3	5	2	1
D	4	3	7	6	2	5	1

12 Which is a correct description of the role of calcium ions in the neuromuscular system?

A exchanged with sodium ions through co-transport channels at axon surfaces during the re-establishment of a resting potential after an action potential

B moved in by diffusion through gated ion channels in pre-synaptic membranes of excitatory neurones causing vesicles to move to pre-synaptic membrane as an impulse arrives

C exchanged with chloride ions at the post-synaptic membrane, in changing membrane potential in inhibitory neurones

D actively pumped out of axons at nodes of Ranvier of myelinated neurones, being the main cause of the potential difference that is maintained during the resting potential

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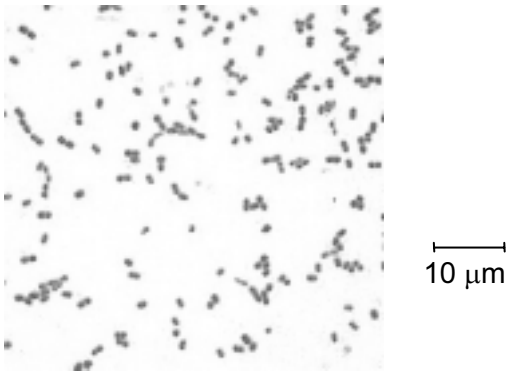
13 Some authors have blended the three domain and five kingdom classification systems to give a six kingdom classification.

The photomicrograph shows some cells of an organism collected from a laboratory worktop and cultured on agar in air.

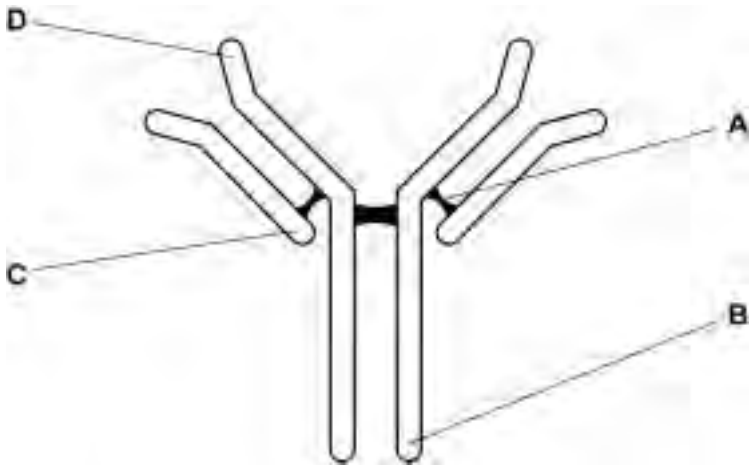


Deduce which of these is most likely to be an appropriate classification of the organism.

	three domain classification	five kingdom classification	six kingdom classification
A	archaea	prokaryotae (monera)	archaea
B	eubacteria	prokaryotae (monera)	eubacteria
C	eukarya	protoctista (protista)	protoctista (protista)
D	eukarya	fungi	fungi

14 The diagram shows the structure of an IgG antibody.

Which shows a variable region of such an antibody?



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15 The endosymbiont theory was first suggested in 1883 by Schimper.

Mereschkowsky, in 1905, suggested that chloroplasts, and Wallin, in 1927, suggested that mitochondria originated by endosymbiosis. Initially they were laughed at.

Which substance do chloroplasts and mitochondria contain that would have been essential if they were free-living organisms before entering into endosymbiosis?

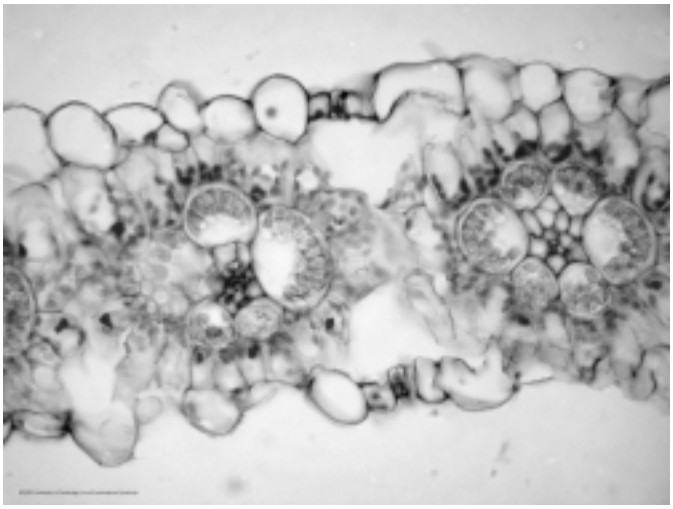
A carbohydrates

B nucleic acids

C lipids

D proteins

16 The photomicrograph shows part of a plant leaf.



What is true about this plant leaf?

A It is from a C3 plant that does not attempt to separate Rubisco and atmospheric oxygen.

B It is from a C4 plant that uses bundle sheath cells to provide spatial separation between Rubisco and atmospheric oxygen.

C It is from a C4 plant that uses bundle sheath cells to provide temporal separation between Rubisco and atmospheric oxygen.

D It is from a CAM plant that uses nocturnal stomatal opening to provide temporal separation between Rubisco and atmospheric oxygen.

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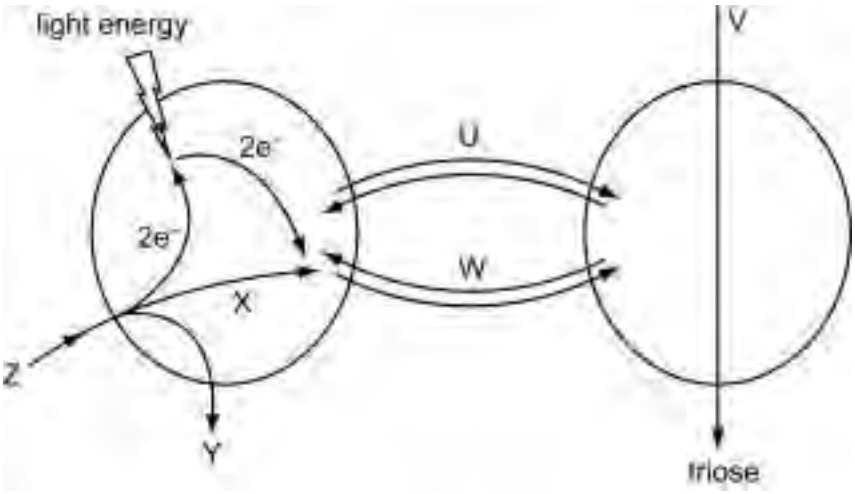
17 The equation shows the complete aerobic respiration of a respiratory substrate.

$$2C_{55}H_{98}O_6 + 156O_2 \rightarrow 110CO_2 + 98H_2O$$

The RQ for respiration of this respiratory substrate is

A 0.70 **B** 0.71 **C** 0.75 **D** 1.42

18 The diagram summarises the reactions of photosynthesis in a C3 plant.



Which of the following correctly identifies the substances involved?

	CO_2	reduced NADP	H_2O	ADP	2H	O_2
A	U	W	Y	V	Z	X
B	U	X	Z	W	Y	Z
C	V	U	Z	W	X	Y
D	V	W	Y	U	X	Z

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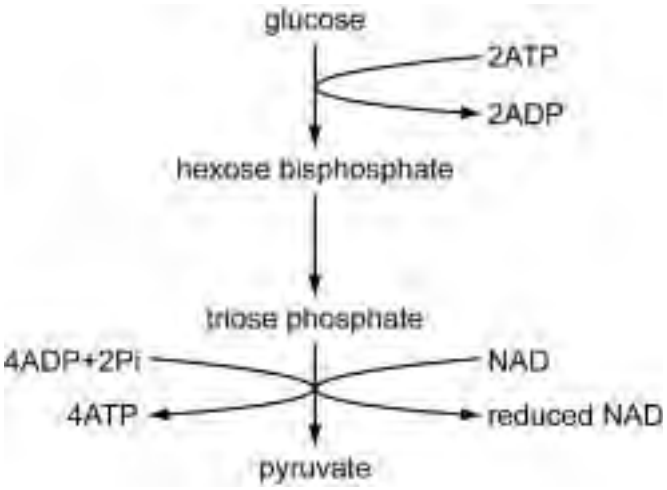
19 The diagram summarises glycolysis.



Which correctly gives the number of carbon atoms and phosphate groups in the four named molecules?

	atom/group	glucose	fructose bisphosphate	glyceraldehyde phosphate	pyruvate
A	carbon	6	6	3	3
	phosphate	0	2	1	0
B	carbon	6	5	5	3
	phosphate	0	2	1	0
C	carbon	6	6	3	3
	phosphate	1	2	1	1
D	carbon	6	5	5	3
	phosphate	1	2	1	1

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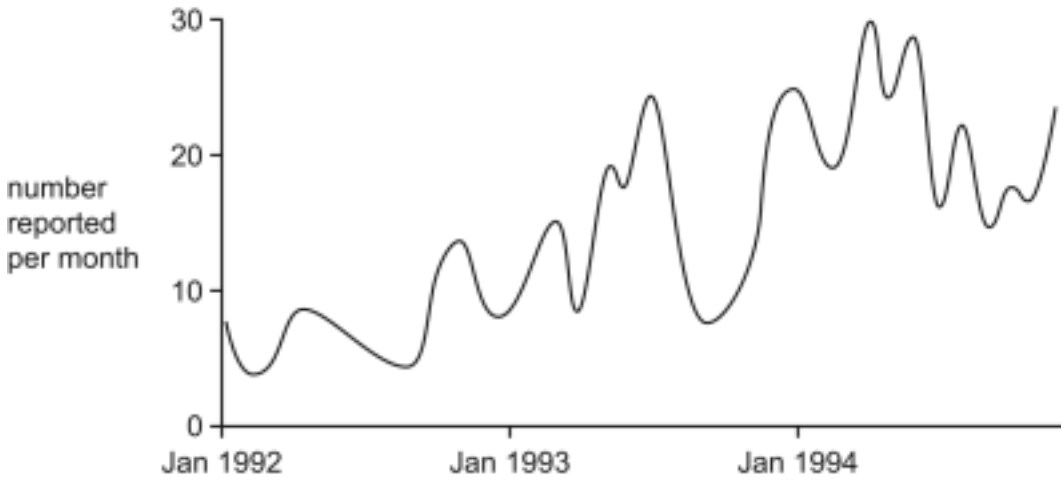
20 The graph shows the change in number of bacterial samples from some New York hospitals that were resistant to the antibiotic vancomycin in 1992–4. 40 samples were taken each month from randomly selected patients who had become infected with bacteria in hospital.



Which of the following most accurately describes the cause of the changes in the frequency of the vancomycin resistant phenotype that occurred?

A effect of artificial selection

B effect of natural selection

C purely due to genetic drift

D purely due to random sampling effects

21 The diagram shows a small organism found in leaf litter in a tropical forest floor.

Which of the following describes the niche of the organism?

A 5 x 106 organisms km^{-2}

B predator of small arthropods, predated by lizards and glossy starling birds, living in moist, tropical conditions under leaf litter

C tropical rainforest of South America, living in moist leaf litter

D was found with ferns, mosses, tropical rainforest trees, worms, arthropods such as woodlice, ants, lizards, glossy starling birds and eagles

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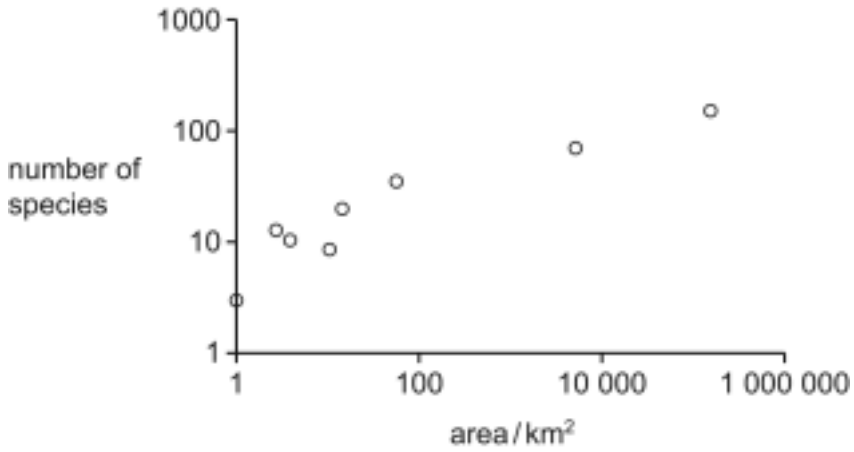
22 The graph shows the relationship between size of sampling area and number of species of long-horned beetles found in Florida. Logarithmic scales are used for both *x*- and *y*-axes.



Which of the following would be an appropriate conclusion for this study?

A the evidence supports the hypothesis that larger areas of Florida have greater biodiversity of long-horned beetle species

B the slope of a line drawn through these points would be quite small so there is little evidence to suggest that larger areas have larger numbers of species

C there is no point making reserves of only 1 km^2 area because they will have too few species in them

D this data proves that as the size of area investigated increases, the total number of species encountered increases

23 The dunnock is a small bird that has many different mating systems including:

- monogamy (one male and one female)
- polygyny (one male, several females)
- polyandry (several males, one female)
- polygynandry (several males and several females)

Which of the following describes the situation that will give a female dunnock the greatest reproductive success?

A monogamy – the territory must support two birds – only one partner is available for the female – both partners help feed the offspring

B polyandry – many males are available and will cooperate to help feed the young with food from their own territories

C polygynandry – the territory must support several birds – several males are available to help feed the young of several females

D polygyny – males are rare and therefore females must compete for opportunities to copulate and must feed the young alone

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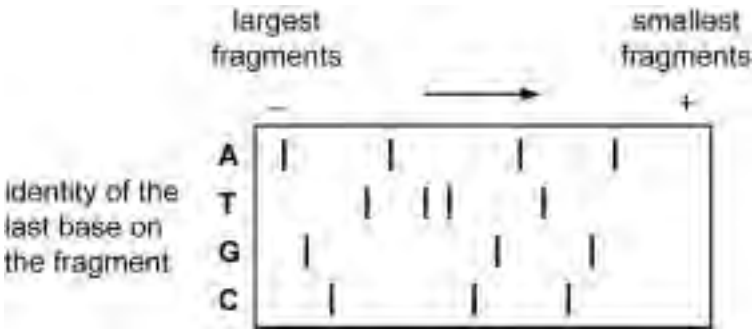
24 The diagram shows part of the result of an electrophoresis process used in the human genome project, which allowed the sequence of bases in DNA to be sequenced.



Which shows the base sequence that this process reveals?

A A G C T G T T G C T A G C A

B A T G C

C A G C T A T T A C G T C G A

D A G C T A T T C G A T C G A

25 In isolating the gene that produces human insulin, reverse transcriptase was used.

Which is the reason that reverse transcriptase is not used for isolating the gene that produces a human sodium ion/calcium ion channel protein?

A The amino acid sequence for this protein is not known so this is a gene that has not yet been located by the human genome project.

B Reverse transcriptase is a viral enzyme, and in the current environment of suspicion of viruses, it is not possible to use such enzymes.

C The antibiotic resistance genes transferred by reverse transcriptase with the insulin gene may be transferred to pathogens.

D The ion channel protein gene is expressed at low levels in human cells so the mRNA produced is swamped by other mRNA.

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Section B

26 The Earth is considered to be 4.6 billion years old. Which of the following are considered to provide evidence that this is true?

1 uranium/lead radioactive decay in western Australian zircon

2 carbon isotope signatures in rocks from Greenland

3 acyclic isoprene molecules in sedimentary rocks from Eastern Europe

4 hopane traces in fossil stromatolites from the USA

A 1 only **B** 1 and 2 only **C** 3 and 4 only **D** 1, 3 and 4 only

27 In rocks from various parts of the world it is claimed that there is evidence of fossil organisms up to 3.6 billion years old.

Which of the following features found in these rocks may be evidence of fossil organisms from 3.6 billion years ago?

1 chemical signatures including archaeobacterial isoprenoids

2 molecular biomarkers including eukaryotic steranes

3 oxidised rocks evidencing a global biospheric oxygenation event

4 stromatolites made up of filamentous and coccoid microfossils

A 2 only **B** 1 and 4 only **C** 2 and 3 only **D** 1, 3 and 4 only

28 Which of the following are advantages of enzyme immobilisation?

1 The active sites of the enzyme molecules are protected from competitive inhibitors.

2 The additional covalent disulphide links may enhance the thermostability of the enzyme.

3 It makes it easier to separate the enzyme from the products so decreasing enzyme contamination.

4 It results in an increased number of available active sites so increasing the rate of reaction.

A 3 only **B** 1 and 3 only **C** 2 and 4 only **D** 1, 2, 3 and 4

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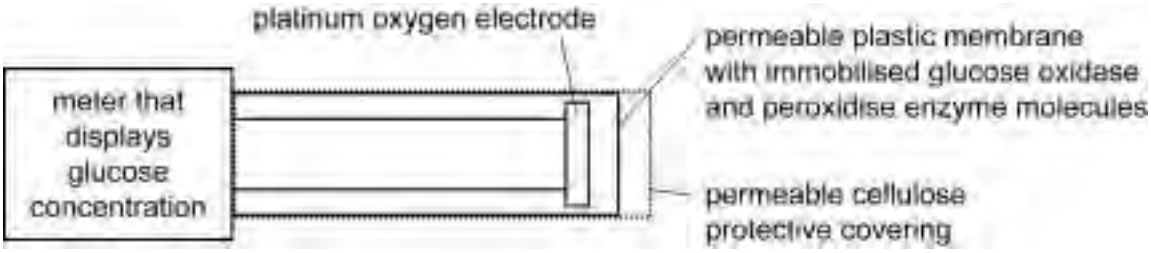
29 The diagram shows a device that measures glucose concentration.



What explains why this electrode is very specific to glucose?

1 The active site of the glucose oxidase enzyme has a shape complementary to that of glucose.

2 The active site of the peroxidise enzyme has a shape complementary to that of hydrogen peroxide.

3 The membranes prevent other small molecules from entering the electrode.

4 The oxygen electrode is sensitive only to changes in oxygen concentration.

A 1 only **B** 2 only **C** 3 and 4 only **D** 1, 2 and 4 only

30 The common ancestor of all animal cells appears to have lost its cell wall during its evolution.

The disadvantages of this include:

1 it removes the anchors necessary for the cytoskeleton to permit easy movement of the cell

2 it removes the pressure potential that gives other cells stability in solutions with water potentials approaching 0 kPa

3 it enhances the ability of bacteria to enter temporary vesicles or secondary lysosomes inside animal cells during phagocytosis

4 it requires the use of energy from ATP to pump water out of organisms for example through contractile vacuoles or kidneys

A 1 only **B** 1 and 3 only **C** 2 and 4 only **D** 2, 3 and 4 only

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31 In three different genetic dictionaries, the genetic code for the amino acid cysteine is given as:

ACA or ACG OR
TGT or TGC OR
UGU or UGC

The explanation for this may be:

1 Some genetic dictionaries show mRNA codons, others show DNA triplets.

2 Some genetic dictionaries show the triplet code complementary to the mRNA code, others show the triplet code for the other strand.

3 The genetic code can be read in either the 3' or 5' direction along the DNA.

4 The genetic code is a degenerate triplet code.

A 3 only **B** 2 and 4 only **C** 1, 2 and 3 only **D** 1, 2 and 4 only

32 The initiation of gene expression in prokaryotes involves which of the following mechanisms?

1 -10 promoters

2 -35 promoters

3 mRNA splicing to remove introns

4 promoters many kb upstream

A 4 only **B** 1 and 2 only **C** 1, 2 and 3 only **D** 1, 2, 3 and 4

33 Which of the following describe processes that lead to an increase in variation?

1 breaking and rejoining in homologous chromosomes during prophase 1 of meiosis

2 random distribution of homologous chromosomes to the cell poles during anaphase 1 of meiosis

3 random variation in allele frequency with time that may result in alleles becoming more common

4 the production of new alleles by substitution of one base for another in DNA

A 1 and 4 only **B** 2 and 3 only **C** 1, 2 and 4 only **D** 1, 3 and 4 only

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34 The diagrams show two gull species found in western Europe, the herring gull and the lesser black backed gull.

These were described as an example of a 'ring species' by Mayr in 1942. It is now thought that they are not 'ring species'.

Which of the following pieces of evidence shows that these gull species may not have originated as 'ring species'?

1 Genetic profiling suggests that the European and North American herring gulls share a common ancestor but neither is descended from the other.

2 Mitochondrial DNA suggests that the ancestors of several of the 'intermediates' are from regions outside the 'ring'.

3 Morphological similarities are much greater than genetic similarities, thought to be due to convergent evolution between gulls of different lineages.

4 There is disagreement among ornithologists whether there are two species with many sub-species or whether there are up to 20 different species of such gulls

A 3 only **B** 4 only **C** 1 and 2 only **D** 1, 2 and 3 only

35 Which of the following are advantages of sexual reproduction compared to asexual reproduction?

1 sexual reproduction increases, from the same energy input, the number of offspring produced per generation

2 advantageous mutations may be brought together into the same individual, enhancing fitness

3 deleterious mutations are more likely to be hidden within the population by advantageous dominant alleles

4 deleterious alleles may be lost from the population after being bought together into the same individual

A 1 only **B** 1 and 3 only **C** 2 and 4 only **D** 2, 3 and 4 only

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36 The photograph shows Dolly the sheep (and her lamb, Bonnie). Dolly was cloned and born at the Roslin Institute in 1996. Sheep of this type normally live to 12 years of age but Dolly died aged 6.

Which of the following have been suggested as having contributed to Dolly's early demise?

1 cartilage cells in her joints aged prematurely due to insufficient telomere length

2 the cell from which she was cloned did not have its telomere length re-set by meiosis

3 the *in-vitro* procedures used caused telomere length re-setting

4 the premature ageing of cartilage in her joints resulted from excessive telomere length

A 1 and 2 only **B** 1 and 3 only **C** 2 and 3 only **D** 2 and 4 only

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37 The photograph shows a meerkat, a small desert mammal. Like the gerbil (*Meriones* sp.), the meerkat has physiological and behavioural adaptations to the challenges posed by the desert environment.

Which are physiological and behavioural adaptations typical of such desert animals?

1 long loops of Henlé in the kidney

2 strong front claws for digging

3 excrete small amounts of concentrated urine

4 offspring born in the canopy of trees

A 1 only **B** 2 and 3 only **C** 3 and 4 only **D** 1, 2 and 3 only

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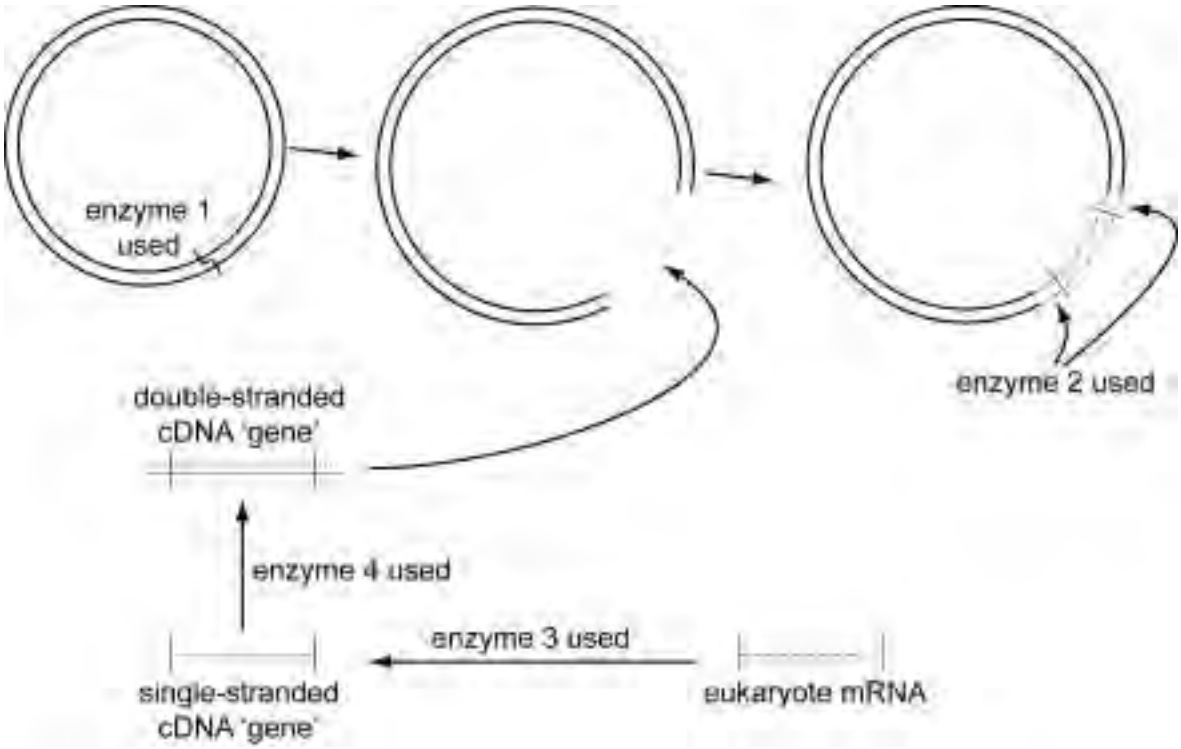
38 The diagram shows part of a process used for genetic engineering.



Which shows the identity of the enzymes used in this part of the process?

1 reverse transcriptase

2 restriction endonuclease

3 ligase

4 Taq Polymerase

A 1 only **B** 4 only **C** 1 and 3 only **D** 2 and 4 only

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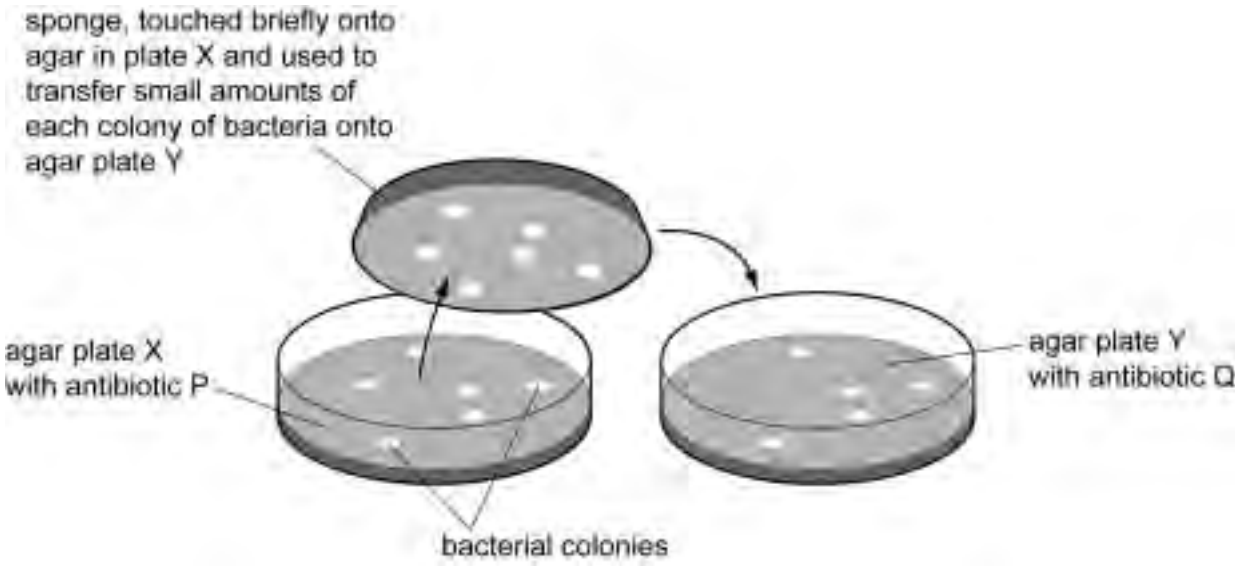
39 The diagram shows a method used to detect which bacteria have been successfully transformed during genetic engineering.



Which explains why other methods for detecting successful transformation are now preferred?

1. Incorporating heavy-metal resistance genes along with the desired genes means that you can easily kill cells that have not been transformed.

2. Presence or absence of non-toxic fluorescent markers is easy to detect using ultra-violet light.

3. The antibiotic resistance genes previously used as markers might have escaped into the environment.

4. The antibiotic resistance genes previously used as markers killed the transformed cells so they were difficult to use.

A 1 and 3 only **B** 2 and 4 only **C** 1, 2 and 3 only **D** 1, 2, 3 and 4

40 In which ways is the polymerase chain reaction (PCR) similar to the replication of DNA?

1 DNA is heated to break hydrogen bonds

2 DNA unzips

3 free nucleotides are used

4 DNA polymerase enzymes are required

A 1 only **B** 2 and 4 only **C** 1, 2 and 3 only **D** 2, 3 and 4 only

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UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
Cambridge International Level 3 Pre-U Certificate
Principal Subject

BIOLOGY **9790/01**

Paper 1 Multiple Choice **For Examination from 2010**

SPECIMEN MARK SCHEME

1 hour 15 minutes

MAXIMUM MARK: 40

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Question Number	*Key*	*Question Number*	*Key*
1	**C**	21	**B**
2	**A**	22	**A**
3	**C**	23	**B**
4	**C**	24	**D**
5	**A**	25	**D**
6	**C**	26	**A**
7	**A**	27	**B**
8	**D**	28	**A**
9	**A**	29	**A**
10	**C**	30	**C**
11	**C**	31	**D**
12	**B**	32	**B**
13	**B**	33	**C**
14	**D**	34	**D**
15	**B**	35	**C**
16	**B**	36	**A**
17	**B**	37	**D**
18	**C**	38	**B**
19	**A**	39	**D**
20	**B**	40	**D**

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Principal Subject

CANDIDATE NAME

CENTRE NUMBER | | | | | |

CANDIDATE NUMBER | | | | |

BIOLOGY **9790/02**

Paper 2 Structured **For Examination from 2010**

SPECIMEN PAPER

1 hour 45 minutes

Candidates answer on the Question Paper.

No additional materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer **all** questions.
Write your answers in the spaces provided on the question paper.

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 **17** printed pages and **1** blank page.

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1 Fig. 1.1 is a diagram of part of an α-helix of a polypeptide chain commonly found in many types of protein.

Fig. 1.1

(a) (i) Name the repeating monomer of a polypeptide chain.

.....

..... [1]

(ii) Explain what would happen to the α-helix if the polypeptide chain was heated to a temperature above 60 °C.

.....

.....

..... [2]

(b) In globular proteins, the polypeptide chain bends and folds to give a more compact shape. The folds always occur in the same places in a molecule of a particular protein. This is called the tertiary structure of the protein.

(i) Name three types of bond that help to maintain the tertiary structure.

1. .....

2. .....

3. ..... [3]

(ii) Suggest why such proteins always fold in the same places.

.....

.....

.....

.....

.....

.....

..... [4]

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(c) Monosaccharides can also be linked together to form long chain molecules called polysaccharides.

For Examiner's Use

Describe how, other than the names of the monomers present, the structure of a polysaccharide differs from that of a polypeptide chain.

.....

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..... [5]

(d) The fibrous protein collagen and the polysaccharide cellulose both possess considerable tensile strength.

Describe the similarities in their structure that give both such tensile strength.

.....

.....

.....

.....

..... [3]

[Total: 18]

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2 **(a)** The red seaweed, *Polysiphonia* sp. has some biochemical similarities to prokaryotic cyanobacteria. It is shown in Fig. 2.1.

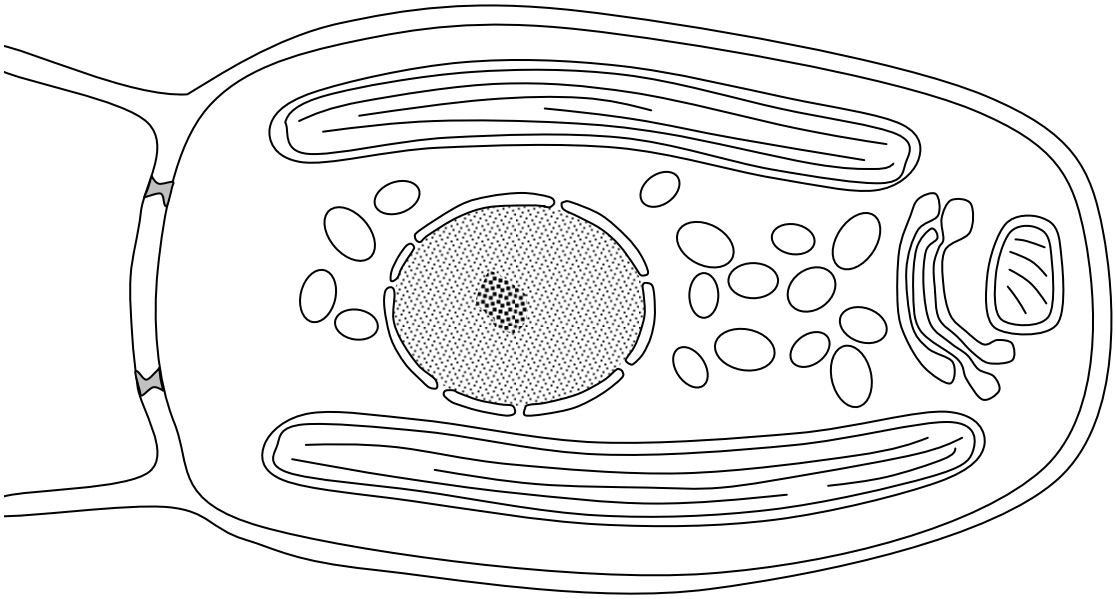

Fig. 2.1

With reference to features visible in Fig. 2.1, explain why *Polysiphonia* is not classified as a prokaryote.

.....

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..... [3]

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(b) A detailed study of the ultrastructure of cells from another red seaweed, *Griffithsia* sp., revealed unusual organelles that resemble chloroplasts and mitochondria from flowering plants. These organelles are always found in close proximity to granules containing a type of starch as shown in Fig. 2.2, which is a drawing made from an electron micrograph.

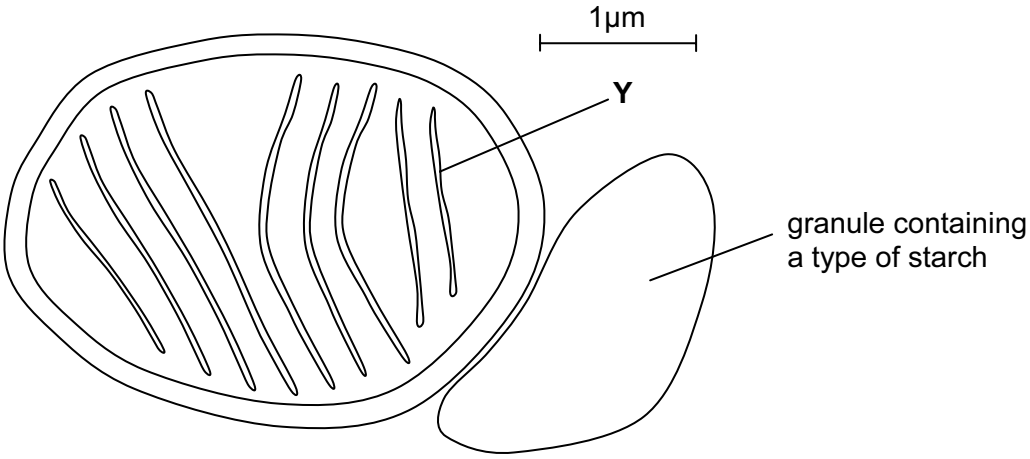

Fig. 2.2

Describe the ways in which this organelle appears to be similar to chloroplasts of flowering plants, and the ways in which it is different.

Similarities .....

.....

.....

.....

Differences .....

.....

.....

..... [4]

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(c) Further study of the membranes labelled **Y** in Fig. 2.2 showed many protein complexes.

For Examiner's Use

These are illustrated diagrammatically in Fig. 2.3.

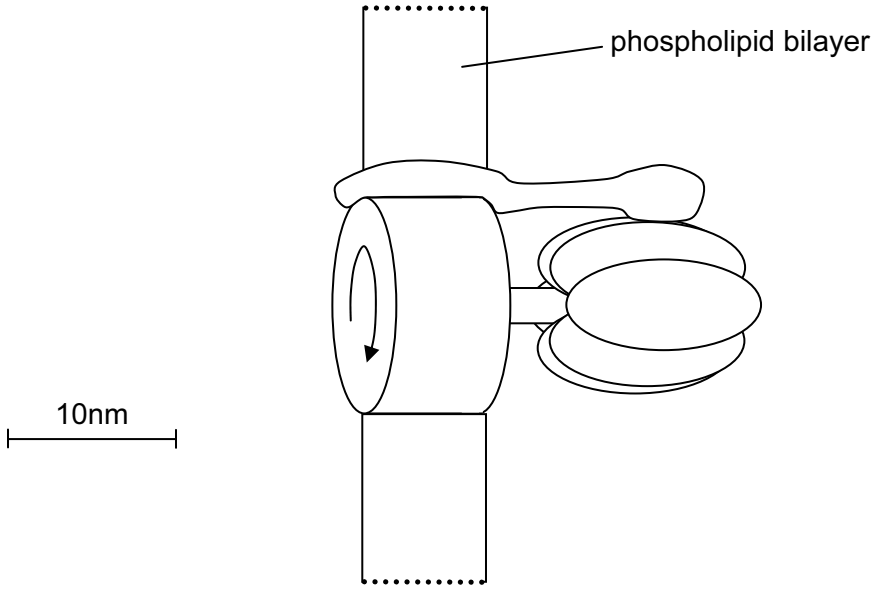

Fig. 2.3

Explain the role of the protein complex shown in Fig. 2.3 in cells and in organelles.

[7]

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(d) Explain how you would investigate the structure and functioning of these organelles to determine their identity.

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[8]

[Total: 22]

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3 **(a)** Explain the factors that, in principle, make genetic engineering possible.

For Examiner's Use

.....

.....

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..... [4]

(b) Compare and contrast genetic engineering and traditional selective breeding.

.....

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..... [3]

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(c) A protein is secreted by a mammalian gland. It is desired to transfer the gene coding for this protein into a number of different types of cell for evaluation of their potential as production systems. The types of cells to be transformed include:

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- a common bacterium, *E. coli*
- a culture of human cells
- a dicotyledonous plant, rapid-cycling *Brassica*
- a yeast, *Saccharomyces*

This question may refer to one, some, or all of these transformations.

(i) Discuss and evaluate the potential methods of isolating the desired gene from the genome of the gene donor. You should include a suggestion of which method would be most suitable, explaining why you have selected this method.

[6]

(ii) It is likely that, in addition to the desired gene, other DNA sequences will need to be transferred into the bacterium.

State the function of one type of DNA sequence that may need to be transferred and explain why this is needed in the transformed *E. coli*.

[2]

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(iii) Fig. 3.1 shows a diagram of the *Agrobacterium*/host cell system. It may contain details that you have not seen before. It is not to scale.

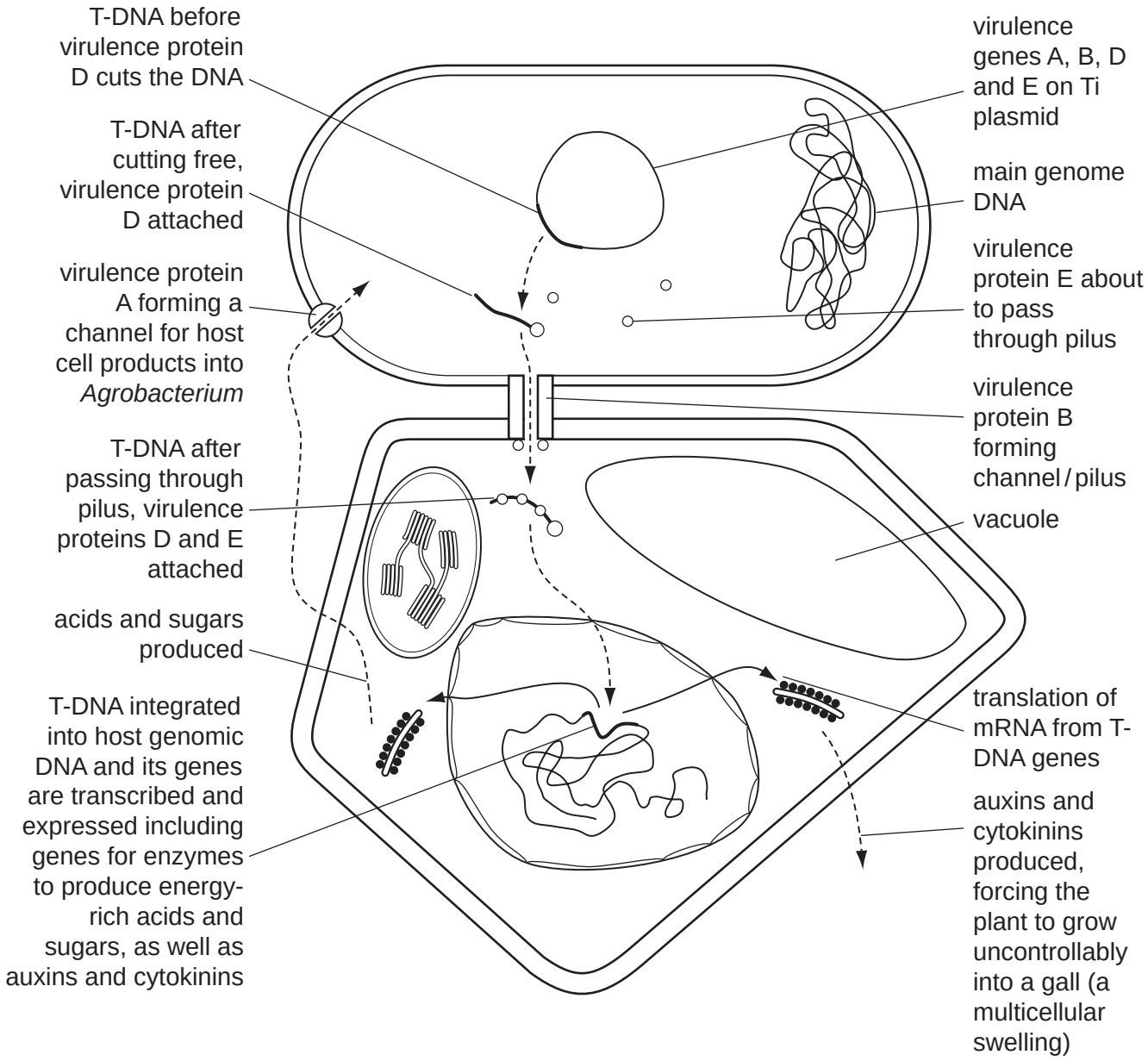

Fig. 3.1

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Use information from Fig. 3.1 and your knowledge and understanding of genetic engineering to explain how this *Agrobacterium*/host cell system can be used to carry out one of the transformations listed in **(c)**.

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[6]

[Total: 21]

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For Examiner's Use

4 In Lake Tanganyika in Africa, there are six species of fish of the genus *Tropheus* and a much larger number of distinctly coloured subspecies of each of the six species. *Tropheus* species are small fish that are confined to isolated rocky habitats around the shores of Lake Tanganyika.

Recent research has compared DNA sequence data from these various species and subspecies and linked this with geological data on the lake.

This suggests that some 1.25 million years ago, when the lake was first filled, the six species evolved during the primary radiation phase. They arose from river dwelling ancestors and then filled all available niches in the lake.

Secondary radiations into the many subspecies occurred during the last 200 000 years. Sometime during this period, the water level in the lake fell, resulting in the formation of three separate lake basins. These basins persisted for many thousands of years before the water level rose again.

Fig. 4.1 shows an outline map of the lake and the location of the three temporary basins caused by lowering of lake levels.

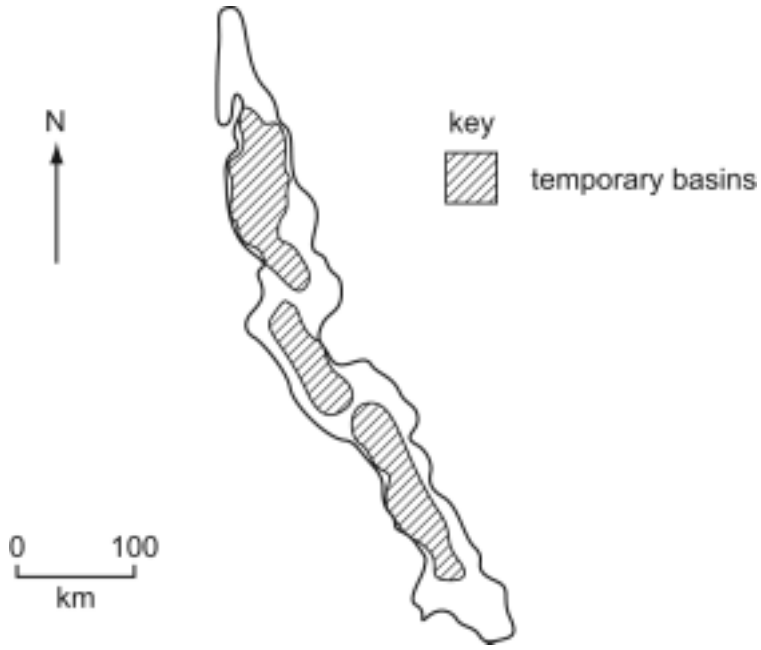

Fig. 4.1

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(a) Define the terms,

species .....

.....

.....

.....

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.....

..... [4]

niche .....

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.....

..... [3]

(b) Explain how natural selection could have caused the evolution of the six closely related species in the primary radiation.

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..... [6]

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(c) Suggest how the lowering of the water level in the lake to form three separate lake basins could have caused the evolution of so many subspecies.

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.....

.....

..... [2]

[Total: 15]

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5 **(a)** Fig. 5.1 shows the process of translation occurring at a ribosome in a cell that synthesises an enzyme that is secreted out of the cell to carry out its function.

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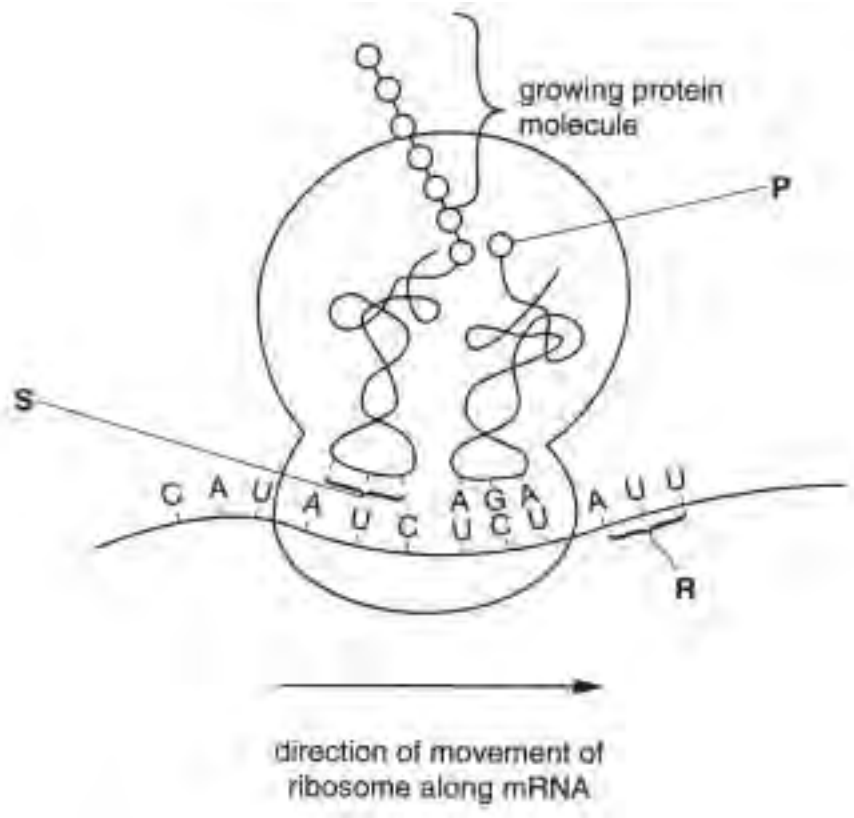

Fig. 5.1

Table 5.1 shows some triplet base sequences of mRNA and the amino acids for which they code.

Table 5.1

mRNA	amino acid
AUU	isoleucine
AUC	isoleucine
AUG	methionine
AGA	arginine
UUU	phenylalanine
UCU	serine
CAU	histidine

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For Examiner's Use

With reference to Fig. 5.1 and Table 5.1,

(i) name the amino acid **P** and state the base sequence at **S**.

amino acid **P** .....

base sequence at **S** ..... [1]

(ii) Describe the change that would occur to the protein if the base sequence at **R** was UUU instead of AUU.

..... [1]

Table 5.2 shows the relative amounts of the bases adenine, thymine, guanine and cytosine in DNA from different organisms.

Table 5.2

source	adenine	thymine	guanine	cytosine
bacterium	23.8	23.1	26.8	26.3
maize	26.8	27.2	22.8	23.2
fruit fly	30.7	29.5	19.6	20.2
chicken	28.0	28.4	22.0	21.6
human	29.3	30.0	20.7	20.0

(b) Explain the importance of the ratios of A to T and G to C to the structure of DNA.

.....

.....

.....

.....

.....

.....

..... [4]

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(c) The bacteriophage virus ϕX-174 has single-stranded DNA with the four bases present in the following relative amounts.

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adenine	thymine	guanine	cytosine
24.0	31.2	23.3	21.5

Suggest why the ratios of A to T and C to G for the virus do not correspond to the ratios found in living organisms.

.....

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..... [3]

[Total: 9]

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Principal Subject

BIOLOGY **9790/02**

Paper 2 Structured **For Examination from 2010**

SPECIMEN MARK SCHEME

1 hour 45 minutes

MAXIMUM MARK: 85

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1 **(a)** **(i)** amino acid; [1]

(ii) hydrogen bonds break;
loses shape/uncoils/disrupted/becomes straight chain;
denatured; [max 2]

(b) **(i)** disulphide/sulphur bridges;
van der waals/AW;
hydrogen;
ionic;
accept hydrophobic interactions; [max 3]

(ii) primary structure/sequence of amino acids, always the same;
IDEA OF interactions between amino acids/some amino acids attract each other/some amino acids repel each other;
example of specific interaction e.g. ref hydrophobic and hydrophilic amino acids/ionic attraction/hydrogen bond formation;
only a few cysteine/only a few amino acids with SH/only a few places disulphide links can form/only specific places disulphide links can form/OWTTE;
AVP; (e.g. ref. chaperones, e.g. detail, e.g. spontaneous assembly of regions of α-helix leaves gaps where folding can occur) [max 4]

(c) (polysaccharide) may be branched;
glycosidic links;
(glycosidic links) form between –COH and HOC–/not between $–NH_2$ and HOC–;
no R groups;
one monomer/repeating unit structure;
angles produced by glycosidic links different to those of peptide links/no α-helix possible/helix with different pitch to α-helix;
AVP; (specific detail of one of the above/alternative valid idea) [max 5]

(d) (both) unbranched;
IDEA OF (both) linear chains of covalently bonded monomers;
(both) made up of the same units repeated;
(both) have hydrogen bonding between adjacent chains;
(both) made up of lots of parallel chains/fibres; [max 3]

[Total: 18]

2 **(a)** ref. membrane bound organelles;
ref. plastids / chloroplasts / mitochondria;
ref. Golgi apparatus / body;
ref. nucleus / nuclear membrane;
ref. nucleolus;
ref. absence of uniquely prokaryote structures including flagellum / mesosome;
ref. pits in cell wall between adjacent cells; [max 3]

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(b) *Similarities*

has two membranes around it / an inner and an outer membrane / AW ;
has membranes within it ;
has starch associated with it / AW ;

Differences

starch outside the organelle / starch not within the chloroplast (in the red seaweed) / or reverse argument if candidate states that answer is in the context of the flowering plant ;

membranes (inside chloroplast) separated from each other / spaced out / not stacked into grana (in the red seaweed) / or reverse argument if candidate states that answer is in the context of the flowering plant ;

accept appropriate references to size compared to the mean size of a flowering plant chloroplast (mean in range 5-6 μm), whereas this is only 3.5 μm long ; [max 4]

(c) diffusion of hydrogen ions through the membrane / down a concentration gradient / through the stator / through the enzyme / AW ;
drives the rotor / makes the stalked particle rotate / AW ;
ATP synthase remains stationary / AW;
which causes conformation changes within the ATP synthase / enzyme ;
synthesising ATP ;
from ADP and inorganic phosphate / Pi ;
ref. production of H^+ ion concentration gradient ;

in mitochondrion
this is the main ATP producer in aerobic conditions ;
ATP required to drive cell processes / example of specific cell process ;

in chloroplasts
ATP is produced using energy from excited electrons /AW ;
ATP used in light independent reaction / Calvin cycle / described ;

in bacteria
ATP produced in cell membrane ; [max 7]

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(d) view isolated organelles under the light microscope ;
(with light microscope) chloroplast will be red (accept green) / mitochondrion/other organelle will be clear ;
view a much larger sample under the TEM to see if the structures can be further resolved

ref. stain an enzyme system found only in chloroplast / mitochondrion / specific example of such a system or such a stain ;

AVP detail; e.g. ref. to use of fluorescent markers / use of confocal/UV microscope

separate the organelles by, size / density ;
using cell fractionation / ultracentrifuge ;
test for chemical reaction specific to, chloroplast / mitochondrion ;
ref. specific example of such a reaction (e.g. Hill reaction in chloroplasts) ;

use oxygen electrode to discover if organelle absorbs or produces oxygen ;
investigate movement of substances across outer membrane, e.g. pyruvate / triose phosphate / glucose / sucrose ;

look for evidence of chemiosmosis proving that organelle could be either a mitochondrion or chloroplast / is not some other kind of organelle / named e.g./ AW;
acidified / proton-rich (chloroplasts and mitochondria will) make ATP (without light, when put in an alkaline medium) with ADP+Pi;
AVP detail;; (e.g. acidification of organelles by putting isolated organelles in pH4 / acid medium for a few minutes, e.g. organelles transferred to an alkaline / proton deficient / pH8.5 medium for test)

look for light-dependent / photo-dependent chemiosmosis / AW;
measure pH of medium in which illuminated organelles are suspended;
pH will reduce in light if organelle is a chloroplast / pH will remain unchanged if organelle is a mitochondrion; [max 8]

[Total: 22]

3 **(a)** all organisms share same genetic code/AW;
each DNA triplet/codon/kind of tRNA, codes for the same amino acid in all organisms;
DNA can be polymerised/replicated outside cells (using PCR);
mRNA can be reverse transcribed to yield DNA/AW;
restriction enzymes/endonucleases, cut DNA at, specific restriction sites/base sequences/to form complementary sticky ends;
AVP; (specific detail of one of the above/alternative valid idea) [max 4]

(b) *similarities*
both involve transfer of genetic material from one organism to another/AW;
IDEA OF selective breeding can be considered as a form of genetic engineering;
differences (to max 2) *for first example, only if both halves of argument are given, give the mark, for the second example, permit either half of the argument for the mark)*
ge single gene transferred vs. sb whole genome;
ge can be done in a single generation vs. sb takes many generations;
ge does not transfer background genes/undesirable alleles of other genes vs. sb transfers background genes/undesirable alleles of other genes/AW;
AVP; (e.g. ge may transfer antibiotic resistance genes (as markers) vs. sb does not spread antibiotic resistance genes) [max 3]

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(c) (i) mRNA and reverse transcriptase;
most suitable because
IDEA OF mammalian gland cell expresses desired gene a lot;
IDEA OF so lots of mRNA present in extracts of such cells;
IDEA OF relatively large proportion of mRNA is from desired gene;
requires a great deal less effort than sequencing the protein or DNA;

from primary structure/amino acid sequence of protein;
restriction endonuclease fragmentation and gene probe;
either of these methods is less suitable because
it is a lot of work when there are easier methods;
either of these methods is most suitable because
valid argument made; (e.g. fragmentation methods may include promoters with desired gene, e.g. starting from final protein means that only the bases actually required are included in the cDNA)

AVP; (e.g. any other valid method) [max 6]

(ii) control sequence/promoter/to turn gene on and off/AW;
eukaryotic regulatory region of DNA/regulates transcription (in prokaryote)/ prokaryotes do not have the same control sequences/AW; [max 2]

(iii) used to transform plant cells; (ignore refs to dicot or monocot)
ref. link between virulence genes and pilus/channel/cutting out of T-DNA;
T-DNA, is separate from genomic DNA/is separate from plasmid/separates from plasmid;
T-DNA passes through pilus/into plant cell/into nucleus/into plant genome/AW;
genes on T-DNA that make auxins and cytokinins will need to be removed so gall does not form/to reduce pathogenicity/AW;
genes on T-DNA that produce sugars/acids/energy for bacterium need to be removed;
ref. to need to add desired gene to T-DNA;
ref. to need to add markers with desired gene/AW;
ref. to need to eliminate/remove untransformed cells;
ref. to need to culture transformed cells forming clone/callus/plantlets/plants; [max 6]

[Total: 21]

4 (a) *species*
similar morphology/behaviour/physiology;
similar biochemistry/genome;
interbreed to produce fertile offspring;
reproductively isolated from other species;
ref. common gene pool;
ref. chromosome number;
ref. common niche;
ref. to problems with definition/e.g. of problem; [max 4]

niche
set of conditions within which an organism lives;
ref. environmental/ecological/within ecosystem;
organism's habitat, what it eats, activities, and interactions with other living things;
accept role/function the organism serves in the ecosystem;
ref. realised and potential niche; [max 3]

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(b) fittest organisms reproduce most, passing on their genes to the next generation/AW;
colonisation of new/unoccupied habitat;
ref. environmental change as lake settled down;
adapt to different environments in different parts of the lake;
ref. to variety of niches;
reproductive/behavioural/sympatric isolation;
allopatric/geographical isolation/accept hundreds of km apart;
ref. to specific selective pressures; [max 6]

(c) ref. geographical barriers causing isolation;
preventing gene flow/interbreeding;
ref. creation of new habitats/different environments; [2]

[Total: 15]

5 **(a)** **(i)** **P** = serine and **S** = UAG; (both required for 1 mark) [1]

(ii) (substitution mutation to DNA) would give phenylalanine (at this point in the primary structure); [1]

(b) 1:1/equal amounts; complementary/(base) pairing/A with T & C with G;
occupy central position in molecule;
ref. copying of strands/replication;
ref. role of hydrogen bonding maintaining particular pairing/holding two strands together;
ref. mutation when pairing ratio lost;
ref. to different size/shape of purines and pyrimidines/A and T/C and G;
AVP; (e.g. detail of hydrogen bonding arrangement) [max 4]

(c) DNA in organisms double stranded;
ref. to no base pairing;
A not same as T as not paired together/C not same as G as not paired together;
complements not locked together/OWTTE;
AVP; (specific detail of one of the above/alternative valid idea) [max 3]

[Total: 9]

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Principal Subject

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER			

BIOLOGY **9790/03**

Paper 3 Long Answer **For Examination from 2010**

SPECIMEN PAPER

2 hours 30 minutes

Candidates answer on the Question Paper.

No additional materials are required.

READ THESE INSTRUCTIONS FIRST

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Write in dark blue or black pen on both sides of the paper.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A
Answer **all** questions.
Write your answers in the spaces provided on the Question Paper.

Section B
Answer **all** questions.
Write your answers in the spaces provided on the Question Paper.

Section C
Answer **one** question.
Write your answer on the Question Paper. Separate answer paper will be available if required.

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.

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Section A

For Examiner's Use

Answer **all** the questions in the spaces provided.

You are advised to spend no longer than 50 minutes on this section.

1 Pure-breeding pea plants with round, yellow seeds were crossed with pure-breeding pea plants with wrinkled, green seeds. The offspring all had round, yellow seeds. These seeds were grown and the resulting plants allowed to self-pollinate.

This produced 1112 offspring with the following characteristics.

630 round, yellow seeds
202 round, green seeds
216 wrinkled, yellow seeds
64 wrinkled, green seeds

(a) A ratio of 9:3:3:1 was expected.

A chi-squared test was carried out to test the significance of the differences between the observed and expected results. This gave a value of 0.47.

probability	0.99	0.98	0.95	0.90	0.50	0.10	0.05	0.02	0.01
at 3 degrees of freedom	0.12	0.19	0.35	0.58	2.4	6.3	7.8	9.8	11.3

With reference to the table of probabilities, explain how the value for the chi-squared test supports the hypothesis that these are two pairs of segregating alleles at two loci.

.....

.....

..... [2]

(b) Using this information, explain, with reasons, how these two characteristics are inherited. The space on pages 2 and 3 may be used for genetic diagrams. Your reasoning may be shown as annotations to genetic diagrams or notes on the lines at the bottom of page 3.

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Space for continuation of answer to **1 (b)**.

For Examiner's Use

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..... [10]

[Total: 12]

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For Examiner's Use

2 Inheritance of human genetic conditions can be studied using pedigrees. Sex-linked traits can be carried on the X or Y chromosome and be either dominant or recessive.

Figure 2.1 shows a human pedigree for a sex-linked trait.

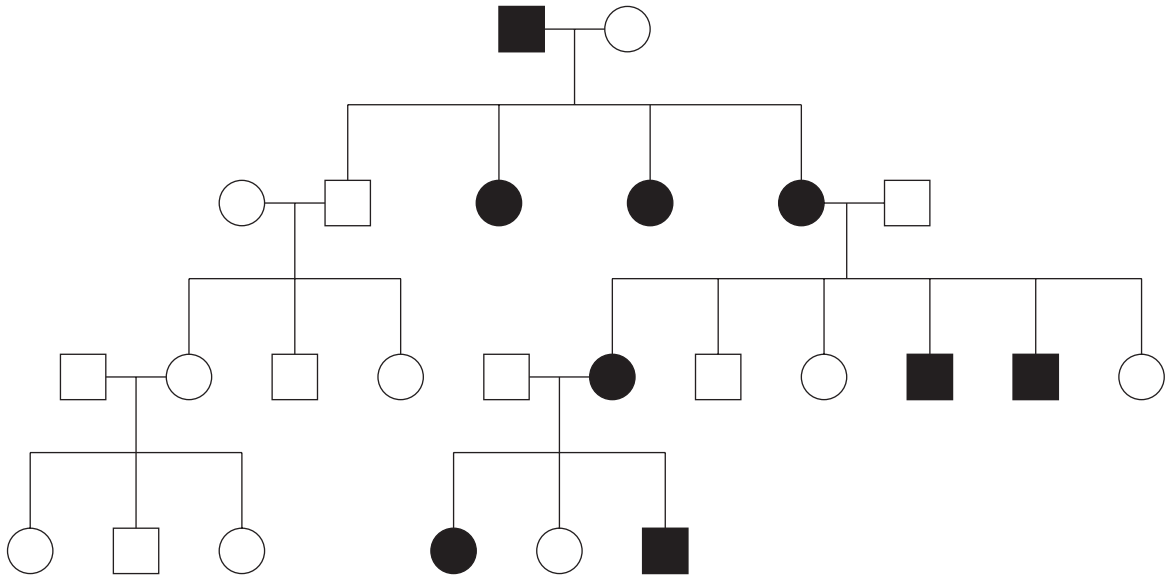
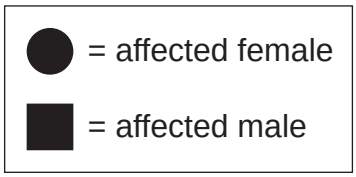


Fig. 2.1



Using the information provided, including both the text and Fig. 2.1, deduce, explaining all stages of your deduction, what is the most likely mode of inheritance for this condition.

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..... [7]

[Total: 7]

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3 An athlete pedalled on an exercise bicycle at three different workloads from light, **A** to heavy, **C**. At each workload the athlete cycled until exhausted and was then given plenty of time to recover before starting at the next workload.

During the course of each exercise small pieces of leg muscle tissue were removed by muscle biopsy and the glycogen content measured. The removal of tissue did not appear to reduce the athlete's performance.

The results of the muscle biopsies at each workload are shown in Table 3.1 and plotted in Fig. 3.1.

Table 3.1

	muscle glycogen content/g kg^{-1} muscle mass			
time/minutes	0	20	60	120
workload **A**	32	29	24	18.5
workload **B**	28	17.5	11.5	7
workload **C**	26	5		

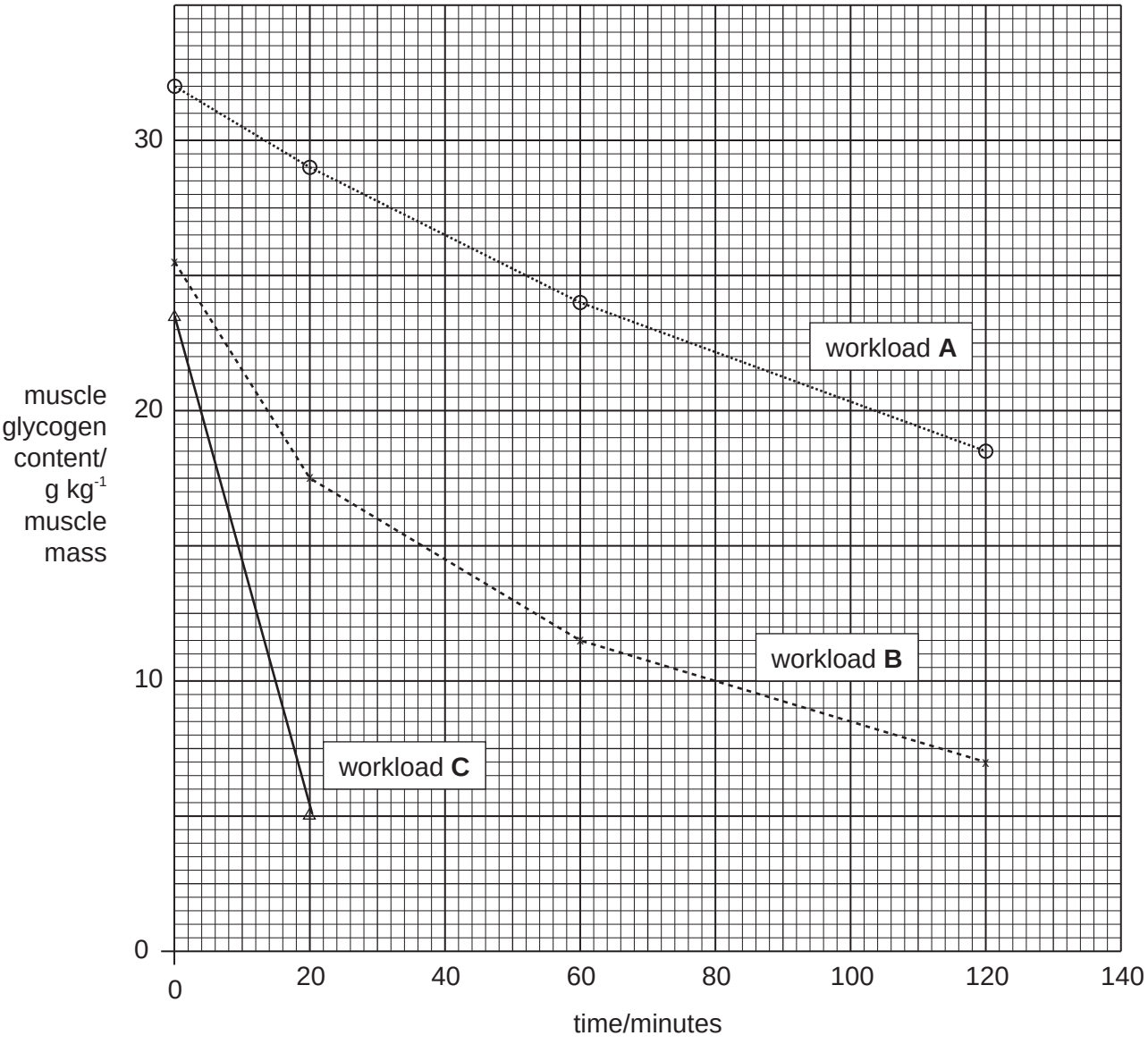

Fig. 3.1

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(a) Using the information in the text, Table 3.1 and Fig. 3.1, compare and contrast the effect of the different workloads.

For Examiner's Use

[6]

(b) Discuss the reasons for the effect of the workload on the muscle glycogen.

[5]

[Total: 11]

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4 In an investigation into pollen release from Timothy grass, the number of pollen grains released into the atmosphere was sampled at hourly intervals, on three consecutive days, by means of traps sited just above the level of the leaves.

The wind speed and the relative humidity were recorded at the times of sampling.

The results of the investigation are shown in Fig. 4.1

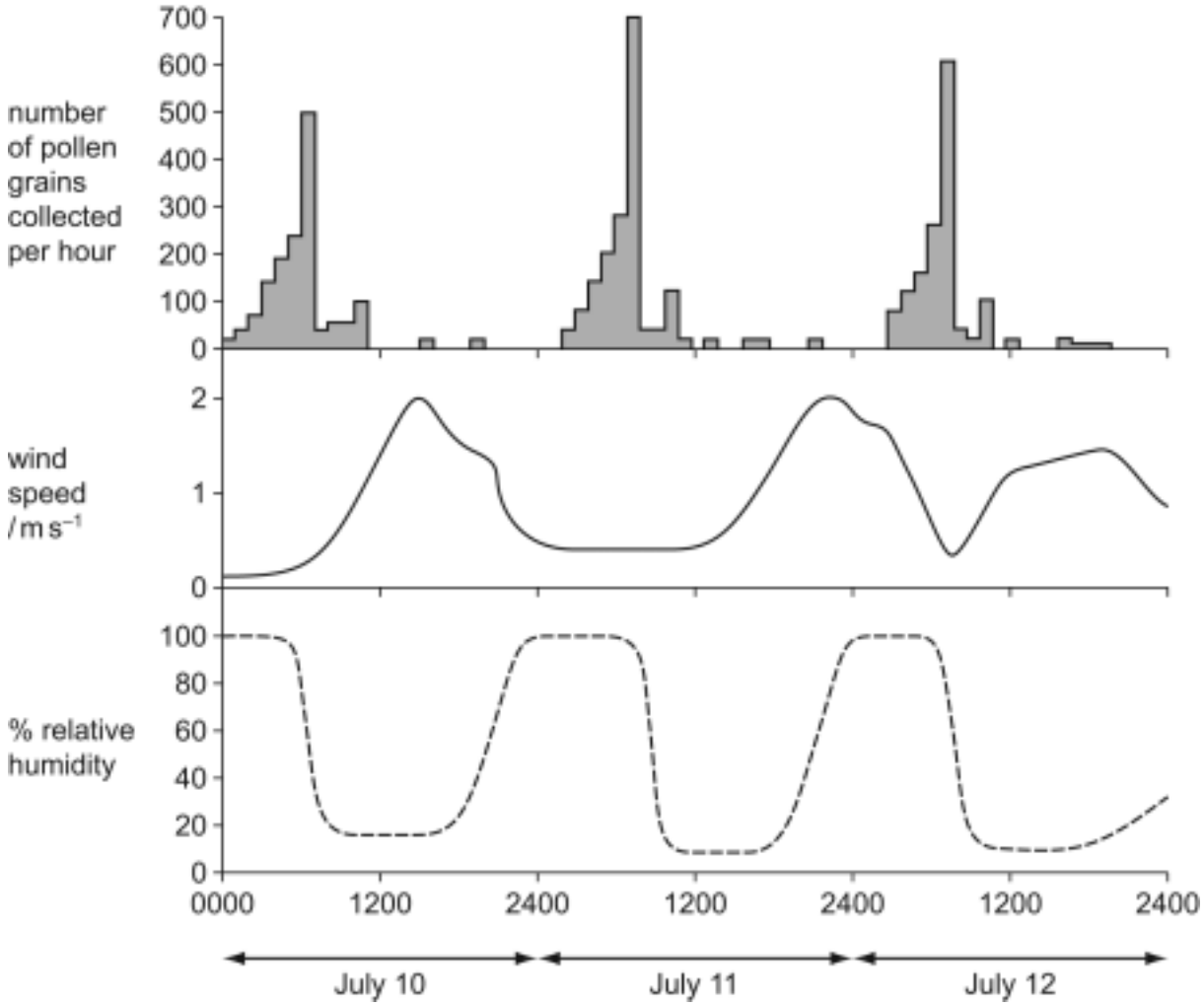

Fig. 4.1

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(a) With reference to Fig. 4.1, describe the key features of the information about release of pollen grains from Timothy grass and draw conclusions.

For Examiner's Use

[7]

(b) Discuss how confident you are that your conclusions are valid.

[3]

[Total: 10]

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Section B

For Examiner's Use

Read the passage carefully and answer **all** the questions in the spaces provided.

You are advised to spend no more than 50 minutes on this section.

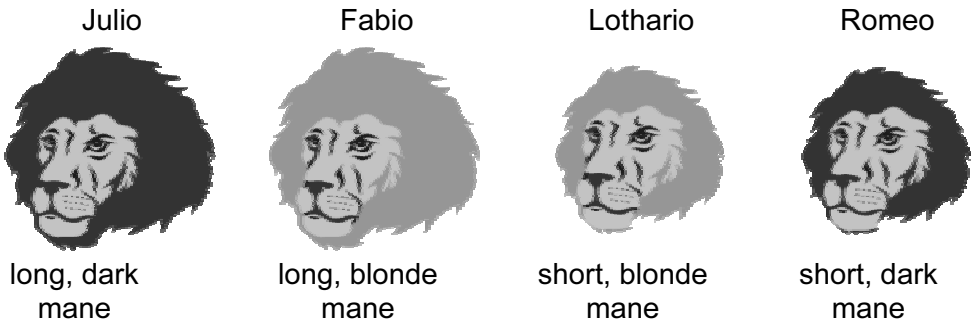
The Lion's Mane

Charles Darwin was the first to suggest that the lion's mane may be as a result of "sexual selection", meaning that the mane had a role in reproductive success.

The lion is uniquely a social cat. Males live in a group called a coalition and attach themselves to a pride of females by successfully removing another coalition. Males compete for mates between other coalitions and within their own coalition. Females within a pride all come into oestrus at the same time, which means that the most dominant males will select their female and defend her. However there are often more females than males leaving the extra females to select their own male.

Experiments were carried out in East Africa, by the Lion Research Centre, at the University of Minnesota.

If the mane is a signal about male condition, then its length or colour should obtain various responses from male and female lions. This was tested with realistic model lions, which were placed in pairs at kill sites. The scientists played a recording of the sounds made by scavenging hyenas, which invariably catches the attention of any real lions that hear it, drawing them in to interact with the model lions at the kill sites. The models are represented below.



Interestingly the models could only be used once for a particular group of lions as on a repeated occasion the lions ignored the models.

The models were used in pairs to test whether mane length or colour produced different responses.

A response was defined as the approach of a lion to a particular model.

models used	Julio and Fabio	Lothario and Fabio
female responses	9 Julio:1 Fabio	3 Lothario:7 Fabio
male responses	0 Julio:5 Fabio	9 Lothario:1 Fabio

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The mane condition is dependent on hormones, health including injury, and nutrition. Hair growth and pigmentation (how much colour) are directly correlated to the level of testosterone. Testosterone is also directly linked to aggression and therefore an animal's ability to fight to defend his female or his cubs.

Sick animals would be unable to hunt or feed as successfully, resulting in for example copper and zinc deficiencies, which can inhibit hair growth and pigmentation.

For Examiner's Use

5 **(a)** State the meaning of the term *oestrus*, used in the passage.

.....

..... [2]

(b) Lions are social animals.

Explain how animals with social behaviours are thought to have evolved.

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..... [5]

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For Examiner's Use

6 A student put forward the following hypotheses.

Females are attracted to darker manes

Males avoid longer manes

(a) Explain how the results would support these hypotheses.

[4]

(b) State two conclusions that could be drawn from ALL of these results.

[2]

(c) Consider the method used and discuss how confident you can be of the conclusions.

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..... [9]

7 Consider Charles Darwin's suggestion that the lion's mane may have developed as a result of "sexual selection", meaning that the mane had a role in reproductive success.

Use the information provided and your skills, knowledge and understanding to explain how this sexual selection would work and the extent to which the results of this investigation are consistent with such an explanation.

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..... [8]

[Total: 30]

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Section C

For Examiner's Use

Answer **one** question on the lined paper that follows.

You are advised to spend no more than 50 minutes on this section of the examination.

Credit will be given for answers that draw from a wide range of syllabus material and also for evidence of reading around the subject.

8 'In a broad sense, all activities of an organism can be regarded as homeostatic'.

Discuss the extent to which this statement is justified in relation to humans.

9 'The greater the biodiversity, the greater the range of ecological niches'.

Discuss this statement with reference to both prokaryotes and eukaryotes.

10 'There is no evolutionary advantage in being multicellular'.

Discuss this view.

[Total: 30]

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UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
Cambridge International Level 3 Pre-U Certificate
Principal Subject

BIOLOGY **9790/03**

Paper 3 Long Answer **For Examination from 2010**

SPECIMEN MARK SCHEME

2 hours 30 minutes

MAXIMUM MARK: 100

This document consists of **11** printed pages and **1** blank page.

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UNIVERSITY of CAMBRIDGE International Examinations

[Turn over

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Section A

1 (a) probability of as large a deviation as 0.47 is between 0.90 and 0.95;
so there is a close fit to the expected results/no significant difference from the expected result; [2]

(b) *Reasoning may be taken from annotations to the genetic diagrams or from written material – the contexts may be provided by location of annotations on diagrams, written information or may be implied or inferred, but do not award reasoning marks if there is no evidence of reasoning (e.g. an unannotated genetic diagram).*

both parents are homozygous since they are pure breeding;
the dominant alleles are round and yellow since all the F1 are round and yellow;
the round and yellow parent is RRYY/homozygous dominant for both genes/accept other notations/letters clearly showing that parent is homozygous dominant for both genes since the F1 are round and yellow; (do not give this mark for RRYY unqualified)
there are two genes each with two alleles/two pairs of alleles segregating at two loci/AW because the results are approximately 9:3:3:1/the chi-squared result supports this hypothesis;
F1 all heterozygous as all have same genotype;
4 different gametes (from F1 self)/RY, Ry, rY, ry because independent assortment occurs during meiosis/gamete formation/prophase 1/AW;
random combination of (4 lots of) gametes (from 2 parents) gives 16 different possible combinations/OWTTE;

AVP;; (e.g. the genes are not linked because this would give a 3:1 ratio/would not give a 9:3:3:1 ratio e.g. there is no epistasis because this would give other ratios/not give a 9:3:3:1 ratio)

[max 5 for reasoning]

first part of genetic diagram; accept any distinguishable symbols and accept described

RRYY X rryy

(RY) (ry)

selfing of F1 shown in diagram; accept description

RrYy X rYry

correct gametes (both RY,Ry,rY,ry); accept from Punnett square or other diagram or description
correct genotypes of offspring (in Punnett square or other diagram or description e.g. below);
correct offspring phenotypes linked to genotypes (in Punnett square, or by a key, or by a table or description);

gametes	RY	Ry	rY	ry
RY	RRYY*	RRYy*	RrYY*	RrYy*
Ry	RRYy*	RRyy#	RrYy*	Rryy#
rY	RrYY*	RrYy*	rrYY+	rrYy+
ry	RrYy*	Rryy#	rrYy+	rryy–

Key * = *round yellow*, # = *round green*, + = *wrinkled yellow*, – = *wrinkled green*

[5 for diagram/description]

[Total: 12]

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2 both females and males affected;
in equal numbers;
therefore not sex-linked on Y;
as not only males affected/or too many females affected;
must be on X;
as occurs in all generations, allele is dominant;
as if it was recessive then normal dominant allele on other X chromosome would mask recessive;
resulting in skipping a generation;
ref. to branches of the family absolutely without the condition; [max 7]

[Total: 7]

3 **(a)** glycogen content decreases with exercise;
all workloads cause glycogen content to decrease;
the heavier the workload, the quicker the glycogen content decreases;
the heavier the workload the greater the decrease in glycogen content;
athlete becomes exhausted quicker with the heavier workload;
workload **C** so intense that glycogen runs out before 60 minutes/athlete exhausted before 60 minutes/AW;
correct use of figs.;
use of calculated gradients; [max 6]

(b) the heavier the workload the harder the muscle has to work;
more energy/ATP is required;
higher respiration rate, uses up available glucose;
blood glucose level drops, stimulates pancreas to release glucagon;
glucagon causes conversion of glycogen to glucose;
AVP; (e.g. detail of conversion, e.g. detail of mechanism of glucagon) [max 5]

[Total: 11]

4 **(a)** majority/most pollen released between midnight and midday;
most pollen released at 7 am each day;
ref. to figs at maximum/500 to 700 pollen grains per hr;
most pollen released when windspeed low;
maximum pollen released when relative humidity high/ora;
very little pollen released when humidity drops low;
very little pollen released when windspeed higher;
refs: to windspeed/humidity figs; [max 7]

(b) Ref. to link between windspeed/humidity and number of pollen grains released, using figures;;
Link to level of confidence, using figures; [3]

[Total: 10]

[Total for Section A: 40]

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Section B

5 **(a)** able/ready/receptive to mate;
ref. fertile;
ref. ovulation; [max 2]

(b) ref. kin selection;
ref. inclusive fitness;
EITHER
kin selection explained
allele (accept gene) which raises survival chances of close relatives (at cost to individual);
(allele) may increase in frequency/be passed on, as close relatives may have the same allele (gene)
the increased fitness of relatives may more than compensate for the loss of fitness of the individual;
OR
inclusive fitness explained
allele (accept gene) which raises survival chances of other members of the same population (at cost to individual);
(allele) may increase in frequency/be passed on, as other members of the populations may have the same allele (gene)
the increased fitness of other members of the population may more than compensate for the loss of fitness of the individual;

AVP; (e.g. example such as ground squirrel) [max 5]

6 **(a)** more females were attracted to Julio/the darker mane;
more males are attracted to Lothario/shorter manes/avoid Fabio/longer manes;
use of comparative figures;; [4]

(b) females are attracted to male lions with darker and longer manes;
males avoid male lions with darker and longer manes/AW; [2]

(c) most/very confident, of females positive responses, to darker/longer manes;
(female response to darker/longer manes) responses very different shown by quote of figs.;
less confident of female responses to longer mane,
(female response to darker manes) responses less difference shown by quote of figs.;
least confident of male responses to mane colour;
shown by ref. too few results/only 5 responses;

no use of statistics to support significance of results;
very small sample sizes for all experiments/too little replication;
results not repeated with same lions, (as lions ignored models on second exposure);
could have been other variable, attracting/repelling lions;
example different environmental conditions as different kills used;
AVP (e.g. whole experiment artificial); [max 9]

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7 (sexual selection is) selection of a mate based on phenotype/physical characteristics/indicators of fitness/AW;
IDEA OF possession of characteristics more attractive to potential mates so one phenotype mates more frequently than another;
females, choose to mate with/are attracted to males, with particular, mane characteristics/length and colour/male condition/AW;
darker and longer maned males are fitter/have better condition/healthier/stronger/AW;
higher testosterone levels linked to darker and longer mane males/AW;
high testosterone acts as an anabolic steroid/builds muscle mass/increases aggression/AW;
high testosterone is directly linked to male's ability to defend his female/cubs/AW;
males only approach blonde and shorter maned males which are less of a threat/AW;
IDEA OF darker and longer mane males more likely to mate with more females as excess females choose the darker and longer mane males/blonde and shorter mane males have fewer matings as less likely to attract excess females/hold onto selected female;
AVP;; (e.g. testosterone linked to higher sperm count/other valid arguments) [max 8]

[Total for Section B: 30]

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Section C

Marking Strategy

Sequence of marker activities for each essay:

1. Familiarise yourself with the expected content.

2. Read through the essay.

3. Write marginal notes on script, highlight evidence of breadth, exemplification and argumentation as well as major and minor errors of fact and irrelevant material.

4. Apply the general descriptors for:

   - Breadth.
   - Argumentation.
   - Communication.
   - Spelling, punctuation and grammar.

5. Match the content of the essay with a descriptor for Scientific Content (20, 16, 12, 8, 4, 0 as appropriate) and then decide whether:

   - all sub-descriptors at that level have been met so that the full mark for that level can be awarded
   - three out of the four sub-descriptors have been met so that intermediate marks can be awarded (18, 14, 10, 6, 2)
   - one or two of the sub-descriptors at that level have been met so that the full mark for the level below can be awarded

Marks should be written at the end of the essay as follows:

B = …….
A = …….
C = …….
S = …….
SC = …….
Total = …….

Breadth **Maximum 3 marks**

Mark		Descriptors
		Candidate has:
3		given a balanced account including most of the relevant topic areas and selected a wide range of facts, principles, concepts and/or examples pertinent to the title
2		given a fairly balanced account including some of the relevant topic areas and selected some of the appropriate facts, principles, concepts and/or examples pertinent to the title
1		given an account including a few of the relevant topic areas and selected a few of the appropriate facts, principles, concepts and/or examples pertinent to the title
0		given an account that relies on one topic area alone and selected a few of the appropriate facts, principles, concepts and/or examples pertinent to the title

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Argumentation **Maximum 3 marks**

Mark		Descriptors
		Candidate has:
3		developed and sustained a coherent argument throughout the essay leading to an appropriate conclusion showing insight
2		introduced an argument and partially developed it but has not sustained it coherently throughout the essay
1		shown evidence of an argument, but has not developed it successfully
0		shown no evidence of argumentation

Communication **Maximum 2 marks**

Mark		Descriptors
		Candidate has:
2		organised and presented information clearly and used correct terminology in appropriate contexts
1		not organised material very well and not used terminology appropriately so that answer has to be re-read
0		presented an unstructured answer with poor use of terminology

Spelling, punctuation and grammar **Maximum 2 marks**

Mark		Descriptors
		Candidate has:
2		used spelling, punctuation and grammar accurately
1		used spelling, punctuation and grammar accurately, but has made significant errors
0		not used spelling, punctuation and grammar accurately

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Scientific Content **Maximum 20 marks**

Mark		Descriptors
		The candidate:
20	a b c d	recalls and consistently uses all facts and principles (relevant to the essay) shows sound understanding of all principles and concepts writes accurately with no major errors, very few minor errors gives detail fully in keeping with that expected of candidates at the end of a programme of study designed to prepare candidates for university
16	a b c d	recalls and consistently uses most facts and principles (relevant to the essay) shows sound understanding of most principles and concepts writes accurately with no major errors, few minor errors gives detail fully in keeping with that expected of candidates at the end of a programme of study designed to prepare candidates for university
12	a b c d	recalls and consistently uses some facts and principles (relevant to the essay) shows sound understanding of some principles and concepts writes some material accurately with not more than one major error, some minor errors gives detail fully in keeping with that expected of candidates at the end of a programme of study designed to prepare candidates for university
8	a b c d	recalls some facts and principles (relevant to the essay) shows understanding of some principles and concepts writes some material accurately with more than one major error or many minor errors gives some detail appropriate for that expected of candidates at the end of a programme of study designed to prepare candidates for university
4	a b c d	recalls a few facts and principles (relevant to the essay) shows limited understanding of a few principles and concepts writes material including many errors some of which may be major errors gives a little detail appropriate for that expected of candidates at the end of a programme of study designed to prepare candidates for university
0	a b c d	recalls no relevant facts and principles shows no understanding of relevant principles and concepts writes irrelevant material or includes many major errors gives no detail appropriate for that expected of candidates at the end of a programme of study designed to prepare candidates for university

Expected Content

For each of the questions, guidance is given as to the kind of content from the syllabus that may be appropriate to answering the question. Some candidates will include all of these areas and others may write in more detail about these or may include other relevant topics, in each case reflecting the candidate's reading-around the subject and personal research and other interests.

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8 homeostasis is inherent tendency in an organism toward maintenance of internal stability/OWTTE
negative feedback processes defined e.g. where information is fed back into system which responds by self-correction
in maintaining the system at a constant state
ref dynamic equilibrium/equilibrium qualified by description including the 'dynamic' idea
ref. constant flux of molecules/constantly changing external conditions;
IDEA OF both physiological and psychological/cognition and innate sensitivity to external environment
great variety of human behaviours
example of homeostatic or non-homeostatic human behaviour e.g. clothing adjusted to temperature/clothing chosen for other reasons than temperature
homeostasis can apply to cells, tissues, organs, systems and whole body
ref to wide range of activities/7 characteristics of life: nutrition, respiration, excretion, sensitivity, reproduction, movement/locomotion, growth/AW
explanation homeostatic role of/examples from nutrition/respiration/excretion/sensitivity (nervous and hormonal)/locomotion/movement
inclusion of relevant receptors/effectors/negative feedback in review of examples

arguably growing organism not fully in homeostasis
definition of growth
with explanation why not homeostatic
arguably reproduction is not homeostatic
argued as an end to end process
argued as homeostasis of the species rather than the individual
reproduction combats losses through disease and accident
homeostatic except for evolution
arguably ageing not homeostatic
ref. programmed ageing process/telomere length/build-up of somatic mutations
coherent argument why a particular process is not homeostatic, e.g. evolution

9 ecological niche is the unique environment/set of ecological conditions/abiotic and biotic conditions/physical and chemical (and biological) environment, in which a specific species occurs;
including habitat, what it eats, its activities, and its interaction with other living things

biodiversity is number and variety of living organisms
includes genetic diversity, species diversity, and ecological/habitat diversity
IDEA OF includes the variability within and between species and within and between ecosystems
biodiversity is linked to the number of ecological niches/the more kinds of organisms the more niches/the fewer kinds of organisms the fewer niches
since organisms cannot simultaneously occupy the same niche
IDEA THAT organisms evolve to avoid competition and fit existing niches
ecological niches could be said to generate biodiversity suggesting that it is not true (that 'the greater the biodiversity, the greater the range of ecological niches')
could argue that biodiversity and ecological niches are more or less synonymous, therefore meaningless (to say 'the greater the biodiversity, the greater the range of ecological niches')

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diversity among prokaryotes
first organisms were prokaryotes/prokaryotes have been around a long time
not much diversity in structure/all unicellular/no more complex than chains of cells
(but) biochemically very diverse
so can occupy a vast range of niches/emphasis of range of conditions
examples from, range of uses in biotechnology/range of natural (non-extremophile) ways of life (e.g. nitrogen fixers in root nodules/chemosynthetic bacteria in soils)
ref. hot springs/hydrothermal vents/other extreme environments
detail of differences between Archaea and Eubacteria)

diversity among eukaryotes
ref. other microorganisms – fungi, algae/protoctists
ref. multicellular organisms get gradually more complex as result of evolution
triploblastic level of organisation in animals led to greater structural complexity/coelomate animals led to greater structural complexity
leading to greater biodiversity/wider range of niches occupied/different range of niches to prokaryotes
examples from across biotechnology/agriculture/natural environments
bryophytes typically in damp places – link with sexual reproduction, progressive adaptation to land during evolution to flowering plants

10 specified range of multicellular organisms to include animals, plants, some fungi/protoctists e.g. some algae
specified range of acellular/unicellular organisms include prokaryotes/bacteria, some protoctists/fungi e.g. yeasts

prokaryotes evolved first/about 3500 million years ago

discussion of meaning of evolutionary advantage/more likely to survive/more successful/abundant/long-lasting/diverse;

could argue that prokaryotes/unicells are more successful
(perhaps) greater biomass than eukaryotes/multicellular
greater numbers/more ubiquitous/AW
still present and successful (after 3500 million years)
(perhaps) more likely to survive natural disasters/survive in wider range/extreme of physical conditions
some prokaryotes can both photosynthesise and fix nitrogen/ref. unicells forming symbioses with fungi as lichens and their even greater success in these associations

all multicellular organisms are eukaryotes
ref. eukaryotic cells being symbiotic unions of previously separate cells/endosymbiosis
(perhaps) suggesting symbiotic unions superior to prokaryotes
ref. structural diversity of multicellular organisms/complexity/variety of behaviour
ref. to advantages of division of labour between organs/specialised cells
ref. to greater potential compartmentalisation

discussion with respect to evolution
evolutionary dogma is that fitness to survive increases with natural selection
therefore most recently evolved life forms should be superior
this is a flawed argument because natural selection operates on all species all the time
therefore current life forms have equal status in terms of success/can only judge on basis of future possibilities

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could consider further the particular example of humans
humans have more control over environment than any other organism
they are a product of an evolutionary trend towards greater complexity
perhaps control over environment may be greater evolutionary advantage than adaptation to change
e.g. destruction of asteroid before impact

e.g. further details of advantages of unicellular or multicellular state

[Total for Section C: 30]

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UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
Cambridge International Level 3 Pre-U Certificate
Principal Subject

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER			

BIOLOGY **9790/04**

Paper 4 Practical **For Examination from 2010**

SPECIMEN PAPER

2 hours 30 minutes

Candidates answer on the Question Paper.

Additional Materials: As listed on the Confidential Instructions.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A
Answer **both** questions.
Write your answers in the spaces provided on the Question Paper.
You will be given only 35 minutes for each question.

Section B
Answer **all** questions.
Write your answers in the spaces provided on the Question Paper.

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 **18** printed pages.

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Section A

For Examiner's Use

Answer **all** the questions in the spaces provided.

1 You are reminded that you have only **35 minutes** for question 1. You should read carefully through the whole of this question and then plan your use of the time to make sure that you finish all the work that you would like to do.

Respiration is a process which uses enzymes to release energy from biological molecules.

(a) You should aim to spend about **five minutes** on question **1 (a)**.

You are provided with a solution of a biological molecule, **S1**.

Use the materials provided to identify the biological molecule in solution **S1**.

Describe each test that you performed, state the results that you obtained and give the identity of the molecule.

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.....

identity ..... [5]

(b) You should spend no more than **25 minutes** on question **1 (b)**.

You are provided with a suspension of yeast that has been placed in solution **S1**, labelled **S2**.

(i) Carefully use **S2** and the apparatus shown in Fig. 1.1 (page 3) to investigate the quantitative effect of temperature on the enzymes in the yeast. You should present and record your observations and data in a clear, organised and logical way in the space provided **on page 3**.

(ii) Describe practical details of how the apparatus was used to gain reliable results and what was done to make it possible to record data in the procedure that you used in **(b) (i)**. Answer this section on the lined paper **on page 4**.

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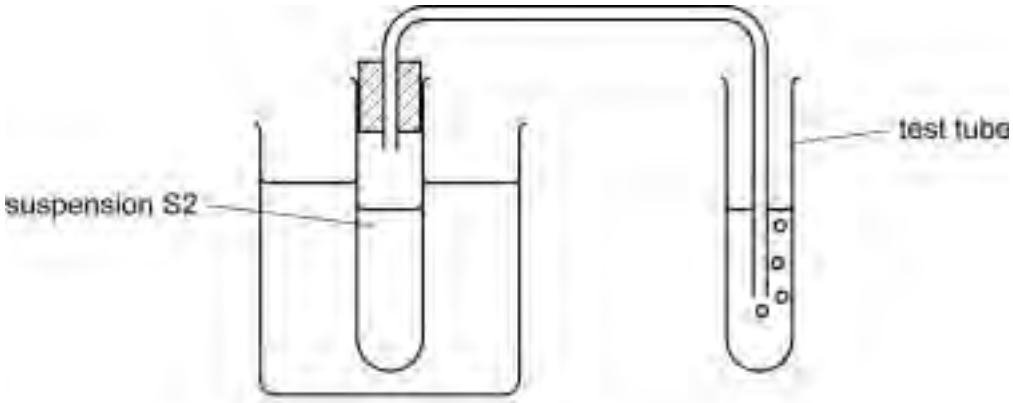

Fig. 1.1

Space to present and record your observations and data in a clear, organised and logical way.

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[7]

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Lined paper to describe practical details of how the apparatus was used to gain reliable results and what was done to make it possible to record data in the procedure that you used in **(b) (i)**.

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..... [3]

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(c) In a student's investigation into the effect of lead nitrate on an enzyme, the time taken for the product to become detectable was measured, in seconds. The data in Table 1.1 was obtained.

Table 1.1

percentage concentration of lead nitrate	time taken for the product to become detectable / s						mean time taken / s
	1st run	2nd run	3rd run	4th run	5th run	6th run	
0.00	3	5	3	2	4	4	4
0.01	6	6	5	3	7	7	6
0.02	7	9	6	5	8	10	8
0.03	10	9	12	11	12	14	11
0.04	16	12	13	16	19	19	16
0.05	21	23	19	22	25	23	22
0.06	33	30	26	31	31	30	30
0.07	43	41	44	21	44	45	
0.08	46	41	42	47	47	45	45

(i) Consider the data in Table 1.1 to identify any anomalies. Then, taking into account this information, **complete Table 1.1** by calculating the missing value for the mean number of gas bubbles produced per minute, at 0.07%.

Show your working and explain any actions that you have taken in the space below.

explanation .....

.....

.....

..... Put your calculated mean value in Table 1.1 [3]

[Total: 18]

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2 You are reminded that you have only **35 minutes** for question 2. You should read carefully through the whole of this question and then plan your use of the time to make sure that you finish all the work that you would like to do.

(a) (i) Draw a low-power plan diagram of the specimen on slide **S4**.

[3]

(ii) Use a ruler to measure the actual size of the specimen on slide **S4** and the size of your drawing across the same point. Draw a line on your drawing to show the size that you have measured. Calculate the magnification of your drawing.

Show your working

magnification ..... [2]

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(b) Starch is stored as granules in some of the cells in the specimen on slide **S4**. Starch is stained purple during preparation of slide **S4**.

In the space below, show your observations of enough of these food storage cells to give a representative sample of the range of their structure. Do not include more observations than are necessary to describe the range of their structure.

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[5]

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(c) (i) Prepare the space below so that it is suitable for you to compare, using a hand lens and microscope, specimen **S3** and the specimen on slide **S4**.

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[1]

(ii) Compare specimen **S3** and the specimen on slide **S4**.

Record your observations in the space that you prepared in question **2 (c) (i)**. [3]

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(d) The photomicrographs, Fig. 2.1 and Fig. 2.2 are taken from a different part of an unfamiliar plant. Fig. 2.1 is a transverse section across the structure, and Fig. 2.2 is a longitudinal section along it.

The passage below describes xylem vessels.

'Mature xylem vessels are large tubes with thick cell walls and no cytoplasm within them. As they mature the cells die, the end walls of the cells break down and they become a continuous tube. They are found within vascular bundles that run along roots, stems and inside the veins of leaves. They do not have companion cells. The cell walls of the xylem vessels or the cells next to them may have rings or spirals of thickening, and may have pits, which are holes through the cell walls connecting cells with the cell next to them.'

Use clear labels and label lines to show the xylem in each of the photomicrographs using the information provided. Explain the reasons for your choice in the spaces provided.

Reasons for choice .....

.....

.....

.....

..... [1]

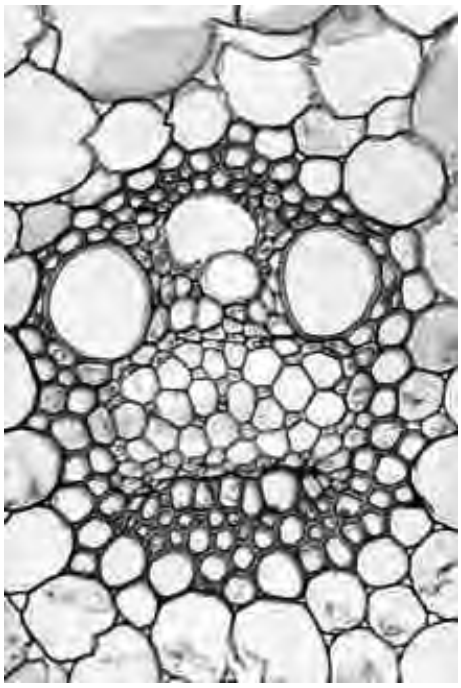

Fig. 2.1

Fig. 2.2 is on page 10.

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Reasons for choice .....

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.....

.....

..... [1]

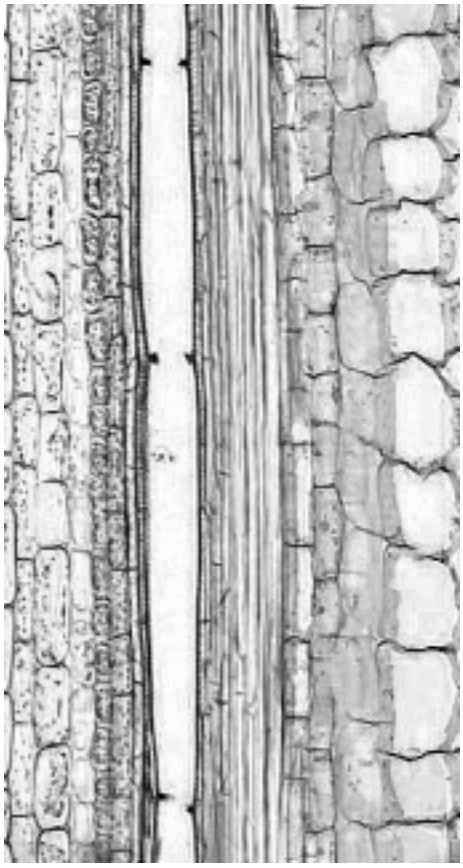

Fig. 2.2

[Total: 16]

Section B begins on page 11.

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Section B

For Examiner's Use

Answer **all** the questions in the spaces provided.

You will have only **80 minutes** to spend on Section B.

3 You are required to plan an investigation into the effect of carbon dioxide concentration on the rate of photosynthesis in an aquatic plant, as shown below.

Fig. 3.1

The concentration of hydrogen carbonate ions in a solution is directly proportional to the concentration of carbon dioxide available to aquatic plants.

You are provided with the following equipment which you may use or not as you wish. You may **not** use any additional equipment.

- five pieces of the aquatic plant shown in Fig. 3.1, each 100 mm long
- a bright white lamp at one end of an otherwise unlit bench 2 metres long
- an accurate electronic top-pan balance and 1 m ruler marked in mm
- an unlimited supply of filtered pond water through which air has been bubbled for at least 24 hours
- an unlimited supply of 0.1 mol dm^{-3} sodium hydrogen carbonate solution
- 5 large test-tubes (125 mm by 30 mm)
- bung to fit the test-tubes with one glass tube passing through
- bung to fit the test-tubes with two glass tubes passing through
- 5 beakers 250 cm^3
- 50 cm^3 burette
- 100 cm^3 measuring cylinder
- 1 m of rubber tube (to fit glass tube) and a pair of scissors
- clip to permit rubber tube to be squashed flat and sealed
- stand, bosses and clamps
- gas jar
- 100 cm^3 gas syringe
- beehive shelf
- electronic push-button counter (display goes up one with each press)
- electronic timer/stopwatch
- a light meter measuring light intensity in candela
- 5 pieces of capillary tube each 300 mm long, with a bore of 1 mm
- large glass trough or transparent tank
- thick sheet of clear glass 150 mm × 100 mm with safe edges

Your plan should include a clear statement of the hypothesis or prediction and should identify key variables.

Your plan should be written in clear scientific language and should be illustrated with a diagram.

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Your plan should give full details and explanations of the procedures that you would adopt to ensure that the results are as precise and reliable as possible. A brief risk assessment should be included.

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[16]

[Total: 16]

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4 Rice is often grown with its roots submerged in water. Barley is a crop that is quickly killed by such conditions. Respiration rate of root cells can be measured as rate of production of carbon dioxide.

In an investigation into the rate of respiration in rice and barley root cells, the data shown in Table 4.1 were obtained.

Table 4.1

	rate of production of carbon dioxide /mmol g^{-1}			
	rice root cells with oxygen	rice root cells without oxygen	barley root cells with oxygen	barley root cells without oxygen
raw data	4.2	5.6	11.1	3.3
	4.7	5.7	9.3	3.3
	4.1	5.2	12.3	2.9
	5.1	5.4	11.6	4.1
	5.2	6.7	11.7	2.8
	3.9	5.1	12.4	3.5
	4.3	5.8	11.5	3.6
	4.1	5.5	11.4	3.3
mean	4.5	5.6	11.4	3.4
standard deviation	0.49	0.49	0.96	0.41
standard error	0.17	0.18	0.34	

(a) (i) Use the formula below to calculate the standard error for barley root cells without oxygen.

$$S_M = \frac{S}{\sqrt{n}}$$

Key

S_M standard error
S standard deviation
n sample number

Write your answer in Table 4.1. [1]

(ii) State what the standard deviations and standard error tell you about the reliability of the results of this investigation.

.....

.....

..... [2]

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(iii) Use the grid to plot an appropriate graph or chart of the mean results for this investigation, including confidence limit error bars.

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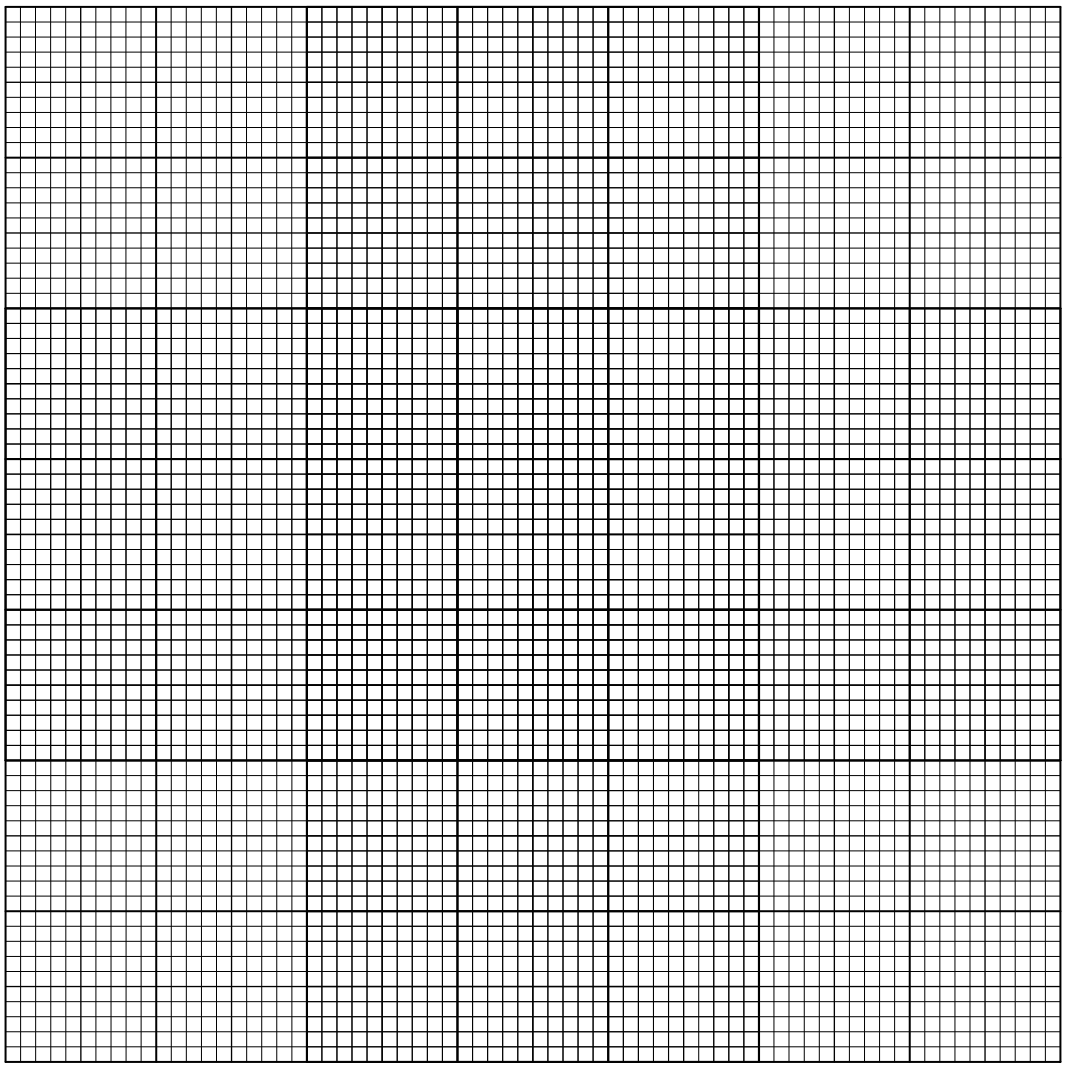

[7]

(b) Explain the difference in the rates of respiration in the sets of seeds used in this investigation.

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.....

..... [3]

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(c) The diagram shows the part of the apparatus used to measure the production of carbon dioxide. The measurement was made by the movement of the drop of coloured oil along the capillary tube, measured using the ruler next to the capillary tube. Fig. 4.1 shows the position of the oil drop before and after it had moved.

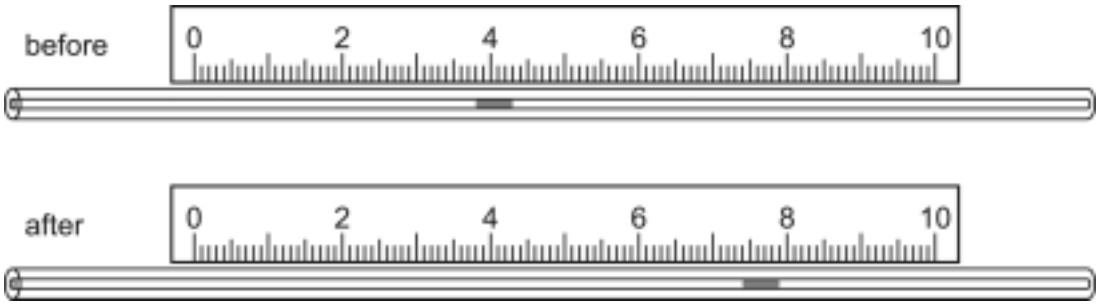

Fig. 4.1

(i) Use the information given to estimate the uncertainty in the measurement of the actual distance moved by the oil droplet.

Show your working.

actual distance moved = ...

uncertainty = ... [1]

(ii) Calculate the uncertainty as a percentage of the actual distance moved.

Show your working.

uncertainty = ... [1]

[Total: 15]

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5 A solution of hormone **Y**, thought to be a growth hormone, was made by dissolving a known mass of hormone **Y** in 10 cm^3 of distilled water. This was added to samples from a culture of animal cells containing 3 000 000 cells per mm^3.

25 mm^3 of the hormone **Y** solution was added to a sample to create an experimental culture of animal cells.

25 mm^3 of distilled water was added to a sample to create a control culture of animal cells.

After three days the number of cells per mm^3 of culture was measured.

Table 5.1 shows the results of this investigation.

Table 5.1

sample number	1	2	3	4	5	6	7	8	9	10	**mean**
millions of cells per mm^3 of culture											
experimental cell culture treatment	7.5	8.1	7.6	6.2	7.5	7.8	8.9	6.5	7.9	7.3	**7.5**
control cell culture treatment	5.6	7.5	8.2	6.7	3.5	6.5	5.9	3.7	5.8	8.4	**6.2**

(a) A student correctly calculated the percentage increase in each culture as follows:

experimental, $\frac{(7.5-3)}{3}\times 100 = 151\%$

control, $\frac{(6.2-3)}{3}\times 100 = 106\%$

Calculate the percentage increase of the experimental culture over the control culture. Show your working in the space below.

[1]

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(b) Discuss the extent to which the results support the hypothesis:

The hormone promotes growth in cell cultures.

.....

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..... [4]

[Total: 5]

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UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
Cambridge International Level 3 Pre-U Certificate
Principal Subject

BIOLOGY **9790/04**

Paper 4 Practical **For Examination from 2010**

SPECIMEN PAPER CONFIDENTIAL INSTRUCTIONS

Great care should be taken to ensure that any confidential information given does not reach the candidates either directly or indirectly.

This document consists of **4** printed pages.

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Instructions for preparing apparatus

These instructions give details of the apparatus and materials required by each candidate for this paper. Sufficient information is given to permit the Centre to set up and test the apparatus and materials so that the candidates can be fairly assessed. **No access to the question paper is permitted in advance of the examination.**

If a candidate breaks any of the apparatus, or loses any of the material supplied, the matter should be rectified and a note made on the Supervisor's report.

Candidates must be provided with a microscope with:

- low-power objective lens, e.g. X10 (equal to 16 mm or $\frac{2}{3}$″)
- high-power objective lens, e.g. X40 (equal to 4 mm or $\frac{1}{6}$″)
- eyepiece graticule fitted within the eyepiece and visible in focus at the same time as the specimen.

Each candidate should have sole, uninterrupted, use of the microscope for at least 35 minutes in order to carry out question 2.

Supervisors are advised to remind all candidates that **all** substances in the examination should be treated with caution. Pipette fillers and safety goggles should be used when necessary.

HEALTH AND SAFETY

Attention is drawn to the section on Health and Safety in the Pre-U Biology Syllabus. This section covers the Practical Examination as well as the practical work that is done during the course. Centres are reminded that, in UK law, the responsibility for Health and Safety lies with the employer.

Materials used in the examination should display appropriate internationally agreed hazard symbols.

Risk assessments by Centres of chemicals and materials as well as labelling of chemicals and materials and provision of safety equipment should follow the legislation in force in the country in which the examination is conducted.

In accordance with the COSHH (Control of Substances Hazardous to Health) Regulations, operative in the UK, a hazard appraisal of the examination has been carried out.

The following codes are used where relevant.

C = corrosive substance

H = harmful or irritating substance

F = highly flammable substance

O = oxidising substance

T = toxic substance

Centres are reminded that they are **not** permitted to open any question paper envelopes before the examination. Centres are also referred to the Handbook for Cambridge Pre-U Centres 2008, and in particular Section 3.1.2, Security of Question Papers and Examination Materials, as well as 3.3.11.1, Practical Examinations in Science Subjects.

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Instructions to Supervisors

*Each candidate must be provided with the following apparatus and materials for **Section A** only.*

To be supplied by the Centre

Question 1

Each candidate will require, for a period of 35 minutes:

(i) 20 cm^3 of glucose solution S1, labelled **S1**. This should be a 0.5 mol dm^{-3} glucose solution. It could be made by dissolving 9 g of glucose in 80 cm^3 of water and making up to 100 cm^3.

(ii) A small volume (e.g. 10 cm^3) of Benedict's solution in a suitable dispensing bottle, labelled **Benedict's solution**.

F (iii) A small volume (e.g. 10 cm^3) of ethanol or industrial methylated spirit ('meths') in a suitable dispensing bottle, labelled **ethanol**.

(iv) At least 20 cm^3 of distilled water in a small dispensing bottle or a container with a pipette, labelled **distilled water**.

(v) Test-tube rack containing two empty, unlabelled test-tubes, a large test-tube and a test-tube labelled **A**.

(vi) Water-bath to perform Benedict's test, consisting of a Bunsen burner, tripod, gauze and beaker.

(vii) A bung and glass or plastic delivery tube, as shown in Fig. 1.1, to fit the large test-tube in (v).

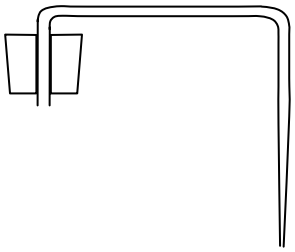

Fig. 1.1

(viii) A beaker large enough to contain 150 cm^3 of water and not overflow when the large test-tube is dipped in the water. This could be the same beaker as is used for the waterbath in (vi).

(ix) Access to a tap dispensing water at, or below, room temperature.

(x) 20 cm^3 of yeast suspension S2, labelled **S2**. This should be made using a 1.0 mol dm^{-3} glucose solution. It could be made by dissolving 18 g of glucose in 80 cm^3 of water. This can be made up several days before the examination. About half-an-hour before the examination, 1 g of dried yeast powder or granules should be thoroughly stirred into the glucose solution, and this should be made up to 100 cm^3 before the yeast starts to ferment and produce foam, which will make measurement of the volume difficult.

(xi) Thermometer capable of measuring at least from 0 to 60 °C (e.g. a standard -10 to 110 °C laboratory thermometer would be suitable).

(xii) A Bunsen burner. This could be the same burner as is used to heat the waterbath in (vi).

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Question 2

Each candidate will require for a period of 35 minutes:

(i) Specimen **S3**, a slice from a carrot, between 1 cm and 6 cm in diameter, and between 0.5 and 1 cm thick. The central stele should be clearly visible in the carrot used.

(ii) Slide **S4**, a transverse section of *Ranunculus* root, suitably stained to show the central stele and starch grains in the parenchyma cells. (A suitable slide may be purchased from CIE, through the publications catalogue – for live examination, such slides are provided by CIE).

(iii) Hand lens (e.g. X10).

(iv) The microscope described on page 2.

(v) A transparent plastic ruler marked in mm.

Section B, Question 3, 4 and 5 requires no apparatus as the syllabus states that 'Section B of component 4 will **not** require laboratory facilities'.

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UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
Cambridge International Level 3 Pre-U Certificate
Principal Subject

BIOLOGY **9790/04**

Paper 4 Practical **For Examination from 2010**

SPECIMEN MARK SCHEME

2 hours 30 minutes

MAXIMUM MARK: 60

This document consists of **12** printed pages.

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Skill	*Total marks*	*Breakdown of marks*		*Q1*	*Q2*
Section A Manipulation, measurement and observation	24 marks	Successful collection of data and observations	14 marks	7	7
		Nature of measurements or observations	10 marks	6	4
Section A Presentation of data and observations	10 marks	Recording data and observations	4 marks	2	2
		Display of calculation and reasoning	3 marks	2	1
		Data layout	3 marks	1	2
Total	34 marks		34 marks	18	16

Skill	*Total marks*	*Breakdown of marks*		*Q3*	*Q4*	*Q5*
Section B Planning	16 marks	Defining the problem	5 marks	6		
		Methods	11 marks	10		
Section B Analysis, conclusions and evaluation and Presentation of data and observations	17 marks 3 marks	Interpretation of data or observations and identifying sources of error	10 marks		9	1
		Data layout	3 marks		3	
		Suggesting improvements and evaluation	4 marks			4
		Conclusion	3 marks		3	
	36 marks		36 marks	16	15	5

MMO = Manipulation, measurement and observation

Collection = Successful collection of data and observations

Decisions = Decisions relating to measurements or observations

PDO = Presentation of data and observations

Recording = Recording data and observations

Display = Display of calculation and reasoning

Layout = Data layout

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Section A

Question	Sections	Learning outcomes	Indicative material	mark

1 (a)	MMO Decisions
	
	MMO Collection
		• decide how many tests, measurements or observations to perform
		• make and record sufficient, accurate measurements and observations
		• work out what to do from outline instructions given in the form of written instructions or diagrams
			3 different tests;
			
			starch = remains yellow/brown;
			ethanol emulsion, shake = clear/alternative lipid test;
			benedicts (+ heat) = red/orange/yellow (R green);
			heat/named temperature between 85°C and 100°C (for benedict's test) (R warm)
			identity = reducing sugar;
			accept glucose or other named reducing sugar
				[1]
				
				[max 3]
				[1]

(b) (i) and (ii)	MMO Decisions	• decide how many tests, measurements or observations to perform • make measurements or observations that span the largest possible range within the limits either of the equipment provided or of the instructions given • make quantitative measurements or qualitative observations that are appropriately distributed within this range • decide how long to leave experiments running before taking observations • replicate readings or observations as necessary • make and record sufficient, accurate measurements and observations	appropriate decisions about practical use of apparatus to gain reliable readings e.g. waterbath used to keep temperatures constant/agitation to ensure that yeast remained suspended/petroleum jelly used to seal bung/time allowed for equilibriation/AVP/AVP;; at least four temperatures investigated; at least two replicate readings made at every temperature;	[2] [1] [1]

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	MMO collection	• set up apparatus correctly • work out what to do from outline instructions given in the form of written instructions or diagrams • use their apparatus to collect an appropriate quantity of data or observations, including quantitative date or subtle differences in colour or other properties of materials;	numerical data successfully recorded e.g. evidenced by faster bubbling rate at higher temperatures (in the range 0–35°C or slower bubbling rate at higher temperatures (in the range 45–100°C); data reported as bubbles per unit time; practical details of what was done successfully to record the data e.g. dots made when bubbling rate got too fast to count/tally chart used/data table drawn out first and data recorded into it/background adjusted to make it easier to see bubbles;	[1] [1] [1]
	PDO recording PDO layout	• present numerical data, values or observations in a single table of results • draw up the table before taking readings/making observations, so that candidates can record directly into the table, to avoid the need to copy up their results • include in the table of results, if necessary, columns for raw data, for calculated values and for deductions • use column headings that include the quantity and the unit (as appropriate) and that conform to accepted scientific conventions • choose a suitable and clear method of presenting the data, e.g. tabulations, chart, graph, drawing or mixture of methods of presentation	all data recorded in a single table that provides sufficient appropriate places (to record bubbling rate per unit time, replicated, at more than one temperature); column headings that include quantities and unit where appropriate (such as temperature/°C, number of bubbles in 10 seconds); all data recorded in a table (where other data unrelated to the main investigation, or un-tabulatable, is recorded outside the table, such as information about room temperature, this may be ignored);	[1] [1] [1]
(c)	MMO Decisions	• replicate readings or observations as necessary (Individual readings or observations should be repeated where they appear to be anomalous)	IDEA OF the fourth reading (was omitted because it) is anomalous/something has gone wrong with the apparatus/the gas bubbles have leaked out somewhere/it was 21 s and all others were in the range 41–45 s/AVP;	[1]

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	PDO display	• show their working in calculations, and the key steps in their reasoning • use the correct number of significant figures for calculated quantities	40 with appropriate working shown;; OR 40 with no working; OR 39.7 or other correct figure with incorrect significant figures with appropriate working shown; 43 with appropriate working shown;	[2]
			[Total: 18]	

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Question	Sections	Learning outcomes	Indicative material	mark
2 (a) (i)	MMO Collection	• set up apparatus correctly • use their apparatus to collect an appropriate quantity of data or observations, including subtle differences in colour or other properties of materials	*Rancunculus* root t.s. recognisable in drawing (large circle containing smaller circle containing star-shaped region); proportions of stele/root diameter acceptable (between 1:5 and 1:10); at least 4 tissues shown (epidermis, parenchyma, endodermis, xylem, phloem);	[3]
(ii)	MMO Collection	• make measurements using millimetre scales, graticules, protractors, stopwatches, balances, measuring cylinders, syringes, thermometers, and other common laboratory apparatus	correct measurement of line shown on drawing to within 1 mm; working shows measurement from drawing divided by measurement from slide/ correct magnification from their data; (ignore position and presence/absence of X, allow ecf from incorrect measurements)	[1] [1]
	PDO Display	• show their working in calculations, and the key steps in their reasoning		
(b)	MMO Collection	• use their apparatus to collect an appropriate quantity of data or observations, including subtle differences in colour or other properties of materials	at least half of area of available space used to represent/describe a number of cells; drawings/descriptions of cells including starch granules, cell walls and air spaces between corners of the cells;	[2]
	MMO Decisions	• decide how many tests, measurements or observations to perform • make measurements or observations that span the largest possible range within the limits either of the equipment provided or of the instructions given • make quantitative measurements or qualitative observations that are appropriately distributed within this range	at least three and no more than ten cells drawn/described; largest cell drawn/described at least twice the size of smallest; cells with a range from 2 or less up to 10 or more starch grains;	[max 2]
	PDO Layout	• choose a suitable and clear method of presenting the data, e.g. tabulations, chart, graph, drawing or mixture of methods of presentation	drawing used to represent observations (clear outline drawings, sharp pencil and no shading);	[1]

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Question	Sections	Learning outcomes	Indicative material	mark
(c) (i)	PDO layout	• choose a suitable and clear method of presenting the data, e.g. tabulations, chart, graph, drawing or mixture of methods of presentation	table used to present data; (R comparative lists without lines to divide information, accept correct alternative structured comparisons such as Venn diagrams or lists matched with linking lines)	[1]
(ii)	MMO Collection	• use their apparatus to collect an appropriate quantity of data or observations, including subtle differences in colour or other properties of materials	Give at least 4 comparisons, (including at least one similarity and at least one difference, and including one subtle judgement [judgement involving more than just size, colour or shape]);	[1]
	PDO Recording	• present numerical data, values or observations in a single table of results • draw up the table before taking readings/making observations, so that candidates can record directly into the table, to avoid the need to copy up their results • record raw readings of a quantity to the same degree of precision and observations to the same level of detail	all observations and comparisons recorded in a single table (or other valid structured comparison); difference(s) recorded to the same level of precision (e.g. sizes recorded in mm) or detail (e.g. stele 40% of total width of **S3** vs. stele 8% of total width of specimen **S4**);	[1] [1]
(d)	MMO Decisions	• make and record sufficient, accurate measurements and observations	correctly label xylem on Fig. 2.1 with correct reasons for choice; correctly label xylem on Fig. 2.2 with correct reasons for choice;	[1] [1]
			[Total: 16]	

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Section B

Planning

P = defining the problem
M = methods

Analysis, conclusions and evaluation

D = Interpretation of data or observations and identifying sources of error
C = Drawing conclusions
E = Suggesting improvements and evaluation

Question	Sections	Expected answer	Mark
3	P	*Hypothesis or prediction* as the concentration of carbon dioxide increases the rate of photosynthesis increases (until another factor becomes limiting); until another factor becomes limiting when increasing the carbon dioxide concentration will have no effect on rate of photosynthesis; *Independent variable*: concentration of carbon dioxide/hydrogen carbonate solution; *Dependent variable*: volume/amount of gas/oxygen collected; accept, rate of photosynthesis *Control variables*: identification of any three appropriate variables; *Risk assessment*: at least two hazards; e.g. hazard associated with hydrogen carbonate solution/hazard associated with the source of the pond water/hazard associated with mass of water/hazard associated with glassware	[6]
	M	ref. to a range of hydrogen carbonate solutions of known concentration/AW; accept, ref. to expose to atmosphere with different known concentrations of CO_2/AW (allow ecf as far as is practicable e.g. if an alternative incorrect independent variable (iv) is selected it has already been penalised, so allow – range of values appropriate to selected iv) a fully quantitative and precise method for measuring the dv selected;;; (collected over water into a burette/movement of meniscus in capillary tube) OR a fully quantitative but imprecise method of measuring the dv selected;; (collected over water into measuring cylinder/collected into gas syringe) OR bubbles counted or collected over water in (uncalibrated) gas jar or test tube; specific practical details;;; e.g. ref. to equilibration time before measuring any gas produced ref. to reading volume after specific time/time to collect stated volume ref. to replication of each reading/run at least 5 times detail of means of ensuring that measuring equipment is read accurately/consistently (allow ecf as far as is practicable e.g. if alternative incorrect dv is selected allow same dv marking points as it was already penalised)	[1] [max 5]

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		details of means used to keep control variables constant;;; *quantity of aquatic plant* – same mass/length/number of leaves/same plant *volume* – same volume of test solution of each concentration *temperature* – immerse the test solution in beaker of water at same temperature/use an air conditioned room/block out heat from lamp using glass sheet *light intensity* – use same light source at same distance from plant/measuring light intensity and adjust position until it is the same;	[max 4]
		[Total: 16]	

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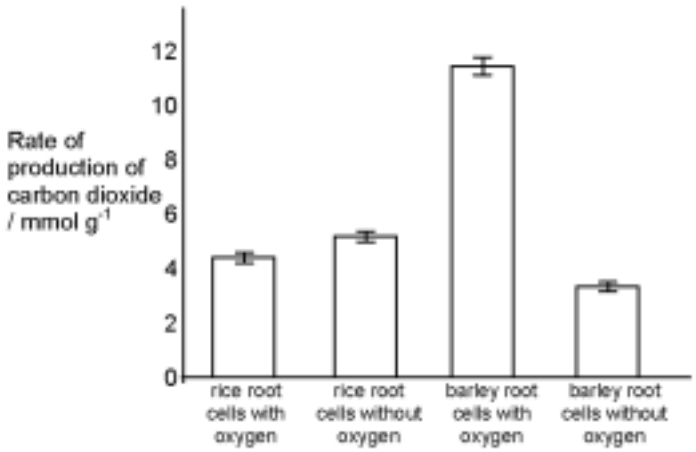
Question	Sections	Expected answer	Mark
4 (a) (i)	D	0.14;	[1]
(ii)	D	barley root cells with oxygen is less reliable than the others; spread of data/standard deviation/standard error is greater; OR significant difference between (all of/any of) treatments; range of standard errors around means/error bars will not overlap;	[2]
(iii)	D D D D	appropriate selection of scales and plot drawn to occupy at least half length of both axes (to permit variability of data to be appreciated); all plots correct (means 4.5, 5.6, 11.4, 3.4); error bars plotted from standard error (accept ±1 standard error/±1.96 standard errors) (R error bars plotted from standard deviation); error bars correctly placed and plotted (allow error carried forward if standard deviation used);	[1] [1] [1] [1]
	PDO Data Layout	axes correct orientation and labelled; (R horizontal bar chart as it has iv on *y*-axis, dv on *x*-axis) Bar/column chart plotted; (R line graph/pie chart) (award this mark even if the bars are touching) Bars not in contact with each other;	[1] [1] [1]
(b)	C	3 of ref. to: ref. slow rate of diffusion of oxygen in water/low partial pressure of oxygen in water; ref. deoxygenation of water by bacteria/respiration/organisms ref. to impact of ethanol produced by anaerobic respiration in plants (e.g. rice is adapted to grow in anaerobic/water logged conditions, rice can tolerate the ethanol produced by anaerobic respiration/barley seeds killed by ethanol produced by anaerobic respiration); aerobic respiration releases more energy than anaerobic (so barley grows faster/more with oxygen); evidence used to support assertion (e.g. rice without oxygen grows better than rice with oxygen/rice grows better than barley without oxygen) AVP;;	[max 3]



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(c) (i)	D	uncertainty ±1.0 mm or ±2.0 mm (accept answers in cm ±0.1 cm or 0.2 cm); *distance is part of working – accept correct answers with no working (already penalised elsewhere on paper) uncertainty for each measurement = 0.5 mm (0.05 cm) or 1 mm (0.1 cm) (as defined in the syllabus)* *when measurements with uncertainties are combined by adding, uncertainties should be added* *units are required, 1 or 2 significant figures should be accepted* *percentage uncertainty is not required here, but for candidates who have gone on to calculate this, award the mark if the working clearly shows the correct uncertainty in mm*	[1]
(ii)	D	accept only answers that are correct calculations based on **(c) (i)**; $\%\,\text{uncertainty} = \frac{\text{size of uncertainty}}{\text{size of measurement}} \times 100$ usually 2.7% or 5.5% or 5.6% but accept correct ecf from any answer for **(c) (i)**	[1]
		[Total: 15]	

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Question	Sections	Expected answer	Mark
5 (a)	D	$\frac{(7.5-6.2)}{6.2}\times 100 = \frac{1.3}{6.2}\times 100 = 0.21\times 100 = 21\%$; accept 21.0% or 20.97% reject 45% as obvious but incorrect	[1]
(b)	E	*support* mean value of experimental cell culture is higher (than control); bottom or range higher/top of range higher, in experimental cell culture (than control)/AW; *does not support* range overlaps/ref. to specific examples of control and experimental samples which are the same (e.g. control 6 and experimental 8 which are both 6.5); ref. to possible anomalies/specific named anomaly from the list experimental samples 4 or 7/control samples 3 or 5 or 10; ref. to insufficient replication (for such variable data); no statistical test of difference carried out/do not know if the difference is significant/no chi-squared test/no t-test/no standard error bars plotted; only one concentration tested/ref. limited range/AW;	[max 4]
		[Total: 5]	

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