CAMBRIDGE
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A Level

Biology

Session: 1994 June
Type: Question paper
Code: 9260

UNIVERSITY OF CAMBRIDGE LOCAL EXAMINATIONS SYNDICATE

General Certificate of Education Advanced Level

BIOLOGY **9260/1, 9261/1**

SOCIAL BIOLOGY **9265/1**

PAPER 1

Thursday **9 JUNE 1994** Afternoon 1 hour

Additional materials:
Multiple Choice answer sheet
Soft pencil (Type B or HB is recommended)
Soft clean eraser

TIME 1 hour

INSTRUCTIONS TO CANDIDATES

Do not open this booklet until you are told to do so.

Write your name, Centre number and candidate number on the answer sheet in the spaces provided unless this has already been done for you.

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

Read very carefully the instructions on the answer sheet.

INFORMATION FOR CANDIDATES

Each correct answer will score one mark. A mark will not be deducted for a wrong answer

This question paper consists of 12 printed pages.

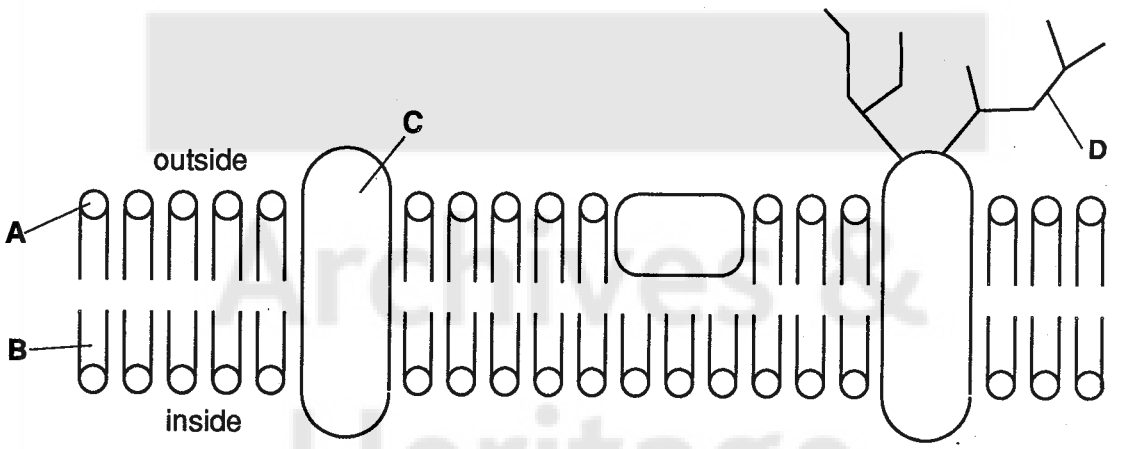
[Turn over

1 A structure is found attached to membranes in cells. It consists of two parts and has a diameter of 20 nm.

What is this structure?

A Golgi apparatus
B lysosome
C mitochondrion
D ribosome

2 The diagram represents a model of the structure of a biological membrane.



Which label indicates hydrophobic hydrocarbon chains?

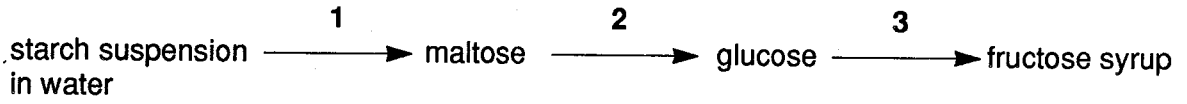
3 When radioactively-labelled amino acids are taken up by secretory cells, what is the sequence of structures in which radioactivity will appear?

	first →		*last*
A	cytoplasm	endoplasmic reticulum	Golgi apparatus
B	endoplasmic reticulum	nucleus	lysosomes
C	lysosomes	nucleus	Golgi apparatus
D	mitochondria	endoplasmic reticulum	lysosomes

4 Which property of proteins enables them to act as pH buffers?

A They are soluble.
B They contain carboxyl and amino groups.
C They have a high molecular mass.
D They possess both secondary and tertiary structures.

5 Fructose syrup is used as a sweetener in the food industry and the scheme below outlines the major steps in its industrial production from starch. The process makes use of bacterial or fungal enzymes at steps 1, 2 and 3.

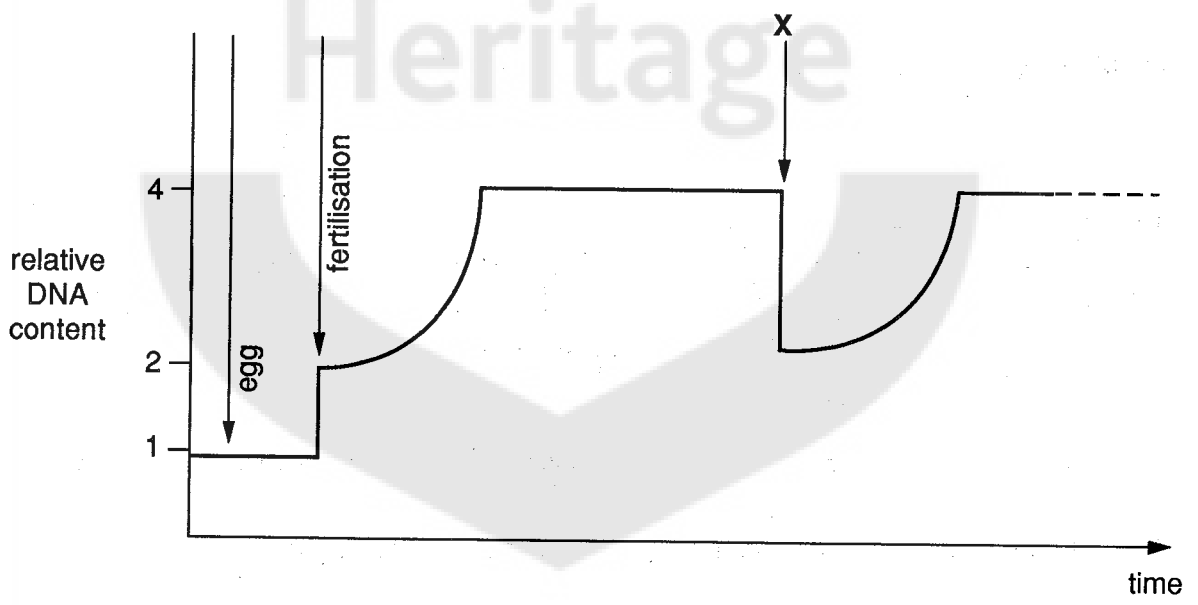


In the table below, ✔ means the step could be carried out by heating the substrate with acid as an alternative to using enzymes. ✘ means that it could not.

Which is the correct combination?

	1	2	3
A	✔	✘	✔
B	✔	✔	✘
C	✘	✔	✔
D	✘	✘	✘

6 The graph represents the changes in the quantity of DNA present in one nucleus at different stages in the life cycle.



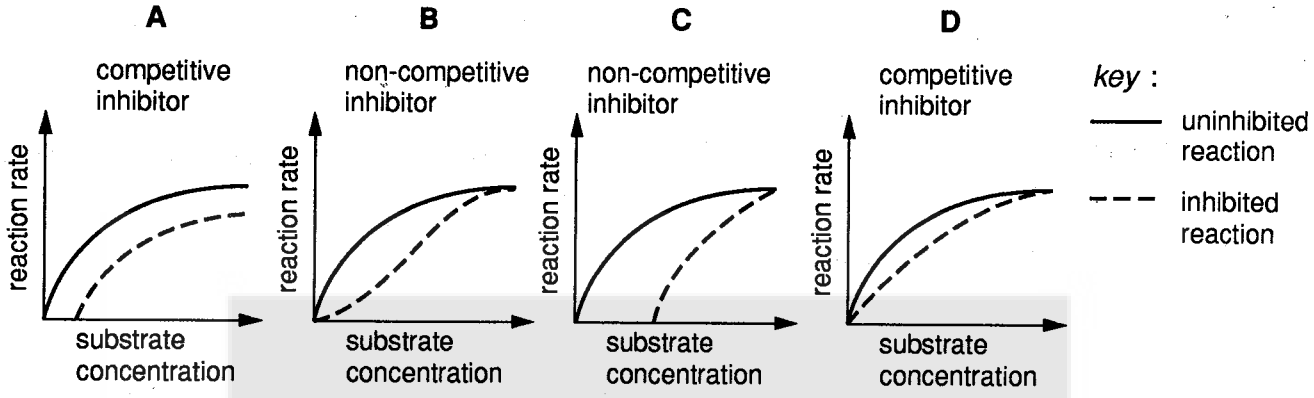
Which stage takes place at **X**?

A interphase
B metaphase
C prophase
D telophase

[Turn over

7 Each graph shows the rate of reaction of an uninhibited enzyme and that of the same enzyme in the presence of a constant amount of either a competitive or a non-competitive inhibitor.

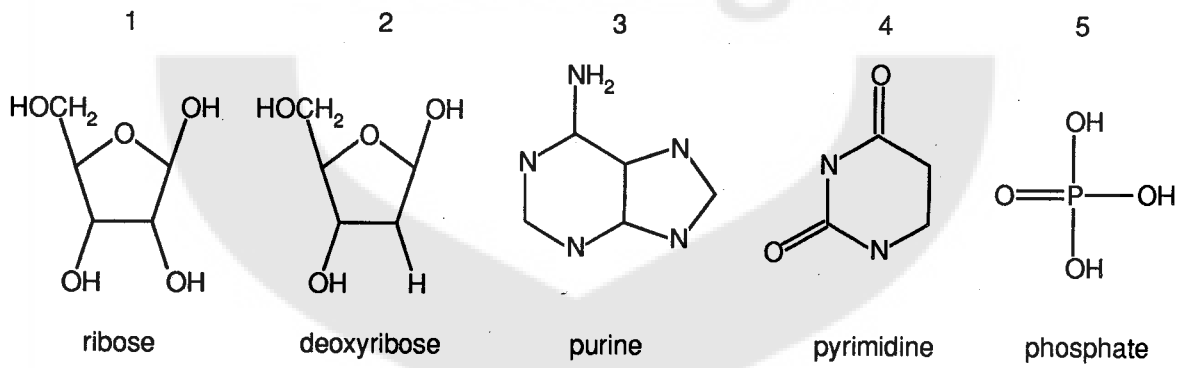
Which graph is correctly labelled?



8 What is the function of the enzyme DNA polymerase?

A to build a strand of DNA using DNA as a template
B to build a strand of DNA using a polypeptide as a template
C to build a strand of mRNA using DNA as a template
D to build a polypeptide using mRNA as a template

9 The following are found in nucleic acids.



Which of these molecules are linked to form a nucleotide containing uracil?

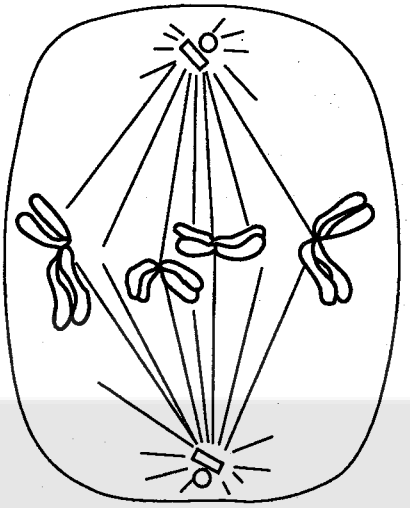
A 1, 2, 3 **B** 1, 3, 4 **C** 1, 4, 5 **D** 2, 3, 5

10 Biochemical analysis of a sample of DNA showed that cytosine formed 40% of the nitrogenous bases.

What percentage of the bases would be adenine?

A 10% **B** 20% **C** 40% **D** 60%

11 The diagram shows two pairs of homologous chromosomes.



Which stage of nuclear division is shown?

A anaphase of mitosis
B anaphase 1 of meiosis
C metaphase of mitosis
D metaphase 1 of meiosis

12 Compared with single ribosomes, polyribosomes, which are complexes of ribosomes, increase the efficiency of protein synthesis.

How is this achieved?

A Different protein molecules can be made simultaneously.
B Each copy of a protein can be made more rapidly.
C More than one copy of the mRNA molecule can be read at the same time.
D Many copies of the same protein can be made simultaneously from one mRNA molecule.

13 The mRNA codons for some amino acids are listed below.

AAU asparagine	AGC serine	ACC threonine
CCA proline	CCU proline	CGG arginine
GCC alanine	GGA glycine	GGC glycine
UCC serine	UCG serine	UGC cysteine

A mutagen causes the adenine in DNA to pair with cytosine during DNA transcription.

Which tripeptide will be synthesised when the DNA fragment ACCTCGAAT is used in protein synthesis in the presence of this mutagen?

A alanine-serine-glycine
B arginine-serine-proline
C asparagine-glycine-arginine
D serine-cysteine-proline

14 How does the second meiotic division differ from mitosis?

In the second meiotic division

A chiasmata form between the chromatids of a bivalent.
B each chromosome replicates to form two chromatids during metaphase.
C exchange of genetic material occurs between chromatids.
D the separating chromatids of a pair differ genetically.

15 A man has normal red-green colour vision. His blood group is rhesus negative (homozygous recessive). His wife also has normal colour vision but is rhesus positive. She is heterozygous at both the red-green colour vision and the blood group loci.

What is the probability that their first child will be a rhesus negative, red-green colour blind boy?

A 0 **B** 0.0625 **C** 0.125 **D** 0.25

16 In guinea pigs, the allele **R** for rough coat is dominant over the allele **r** for smooth coat and the allele **B** for black fur is dominant over the allele **b** for white fur. The genes for fur colour and texture are not linked.

Two guinea pigs with genotype **RrBb** were mated together and one of the offspring had a rough, black coat.

What is the probability that this offspring was homozygous for both rough coat and black fur?

A 1 in 3 **B** 1 in 9 **C** 2 in 3 **D** 2 in 9

17 In *Drosophila*, the male is the heterogametic sex. The allele for white eyes is recessive and sex-linked.

A female which is heterozygous at this gene locus was mated with a normal male.

White eyes will be present in

A all the offspring.
B all the male offspring but none of the female offspring.
C none of the female offspring and 50% of the male offspring.
D none of the male offspring and 50% of the female offspring.

18 Ozone is a gas in the upper atmosphere which absorbs ultraviolet radiation from the Sun.

Which of the following would increase as a direct consequence of the thinning of the ozone layer?

A cancers due to mutation in cells exposed to sunlight
B photosynthesis due to increase in the spectrum of radiation reaching Earth
C rate of carbon fixation due to increased levels of atmospheric CO_2
D sea level due to expansion of water and melting of polar ice caps

19 The sex chromosome combination XYY is found in a small proportion of men.

Such a combination is possible if one contributory gamete to the zygote is

A a sperm produced by a father whose cells lack an X chromosome.
B a sperm produced by non-disjunction at meiosis II.
C an egg containing an X and a Y chromosome.
D an egg produced by non-disjunction at meiosis I.

20 Many bacteria have developed resistance to various antibiotics during the past 40 years.

What does this illustrate?

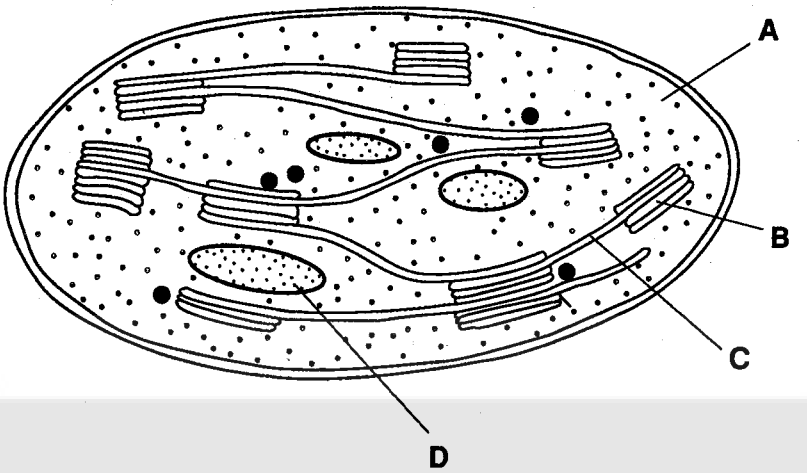
A artificial selection
B hybrid vigour
C natural selection
D polymorphism

21 Which of the following describes conditions in a photosynthesising cell, exposed to high light intensity and low carbon dioxide concentration?

	concentration of CO_2 acceptor	*concentration of ATP*	*concentration of GP (PGA)*
A	high	high	low
B	high	low	low
C	low	high	high
D	low	low	high

[Turn over

22 The diagram shows the main structures in a chloroplast.



Which part is the site of carboxylation of RuBP?

23 The table shows effects of changing levels of CO_2 and/or light on the rate of photosynthesis.

What would be observed, if CO_2 were the initial limiting factor?

	level of CO_2	*level of light*	*rate of photosynthesis*
A	decreased	increased	increases
B	increased	decreased	decreases
C	increased	remains the same	increases
D	decreased	decreased	remains the same

24 For every 100 units of sunlight falling on a chloroplast of a green plant, 50 units are not used for photosynthesis.

Why is this?

A The wavelengths are inappropriate.
B They are converted into heat energy.
C They are used to evaporate water vapour.
D They fall on non-photosynthetic structures.

25 Which substances enter and leave a mitochondrion during aerobic respiration?

	enters	*leaves*
A	acetyl-CoA	carbon dioxide
B	ADP	lactate
C	glucose	reduced NAD
D	pyruvate	ATP

26 The complete oxidation of one mole of glucose yields 2880 kJ of energy.

The addition of one phosphate molecule to ADP requires 30.6 kJ of energy per mole. In aerobic respiration, 38 molecules of ATP are formed as a result of the breakdown of each glucose molecule.

Which figure best represents the efficiency of aerobic respiration in trapping the energy released by the glucose molecule?

A 23% **B** 36% **C** 40% **D** 45%

27 Which of the following would not on its own provide a direct alternative source of protein for human or animal consumption?

A cellulose waste
B marine zooplankton
C saprophytic fungi
D yeast culture

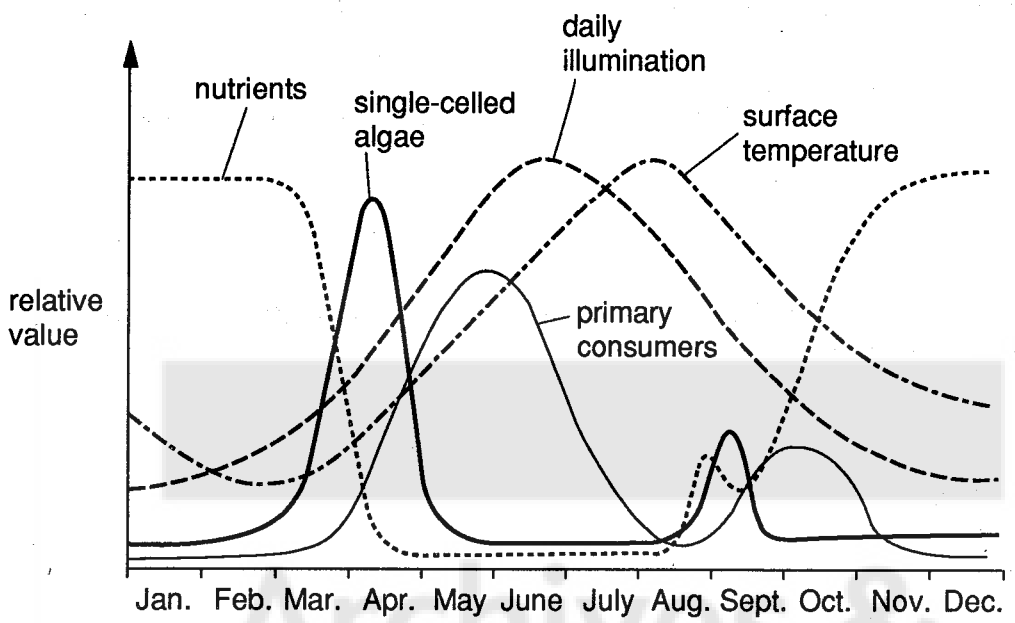
28 Which set of observations provides support for the 'sliding filament' theory of muscle contraction?

	length of actin and myosin filaments	*width of A band*	*width of I band*
A	contract	becomes narrower	no change
B	contract	no change	becomes narrower
C	no change	becomes narrower	no change
D	no change	no change	becomes narrower

29 Which substance is released by the presynaptic membrane of a motor nerve fibre supplying a skeletal muscle cell?

A acetylcholine
B adrenaline
C calcium ions
D cholinesterase

30 The diagram shows some of the factors influencing the cycle of seasonal abundance of single-celled algae in a North American lake.



Which two factors determine the population level of single-celled algae in June, July and August?

A the high level of light and low level of feeding by primary consumers
B the high level of light and high surface temperatures
C the high surface temperatures and low level of feeding by primary consumers
D the low level of nutrients and high level of feeding by primary consumers

31 The rat poison warfarin inhibits the synthesis of the plasma protein prothrombin in the liver.

The effect of warfarin will be to cause the death of rats by

A causing the accumulation of amino acids in the blood.
B preventing the maintenance of the glucose content of the blood.
C slowing the clotting process after internal bleeding.
D stimulating the production of too many red blood cells.

32 Which of the following would result from rebreathing the same air?

	blood pH	*carotid body impulses*	*breathing rate*
A	fall	increase	increase
B	fall	decrease	decrease
C	rise	decrease	increase
D	rise	increase	decrease

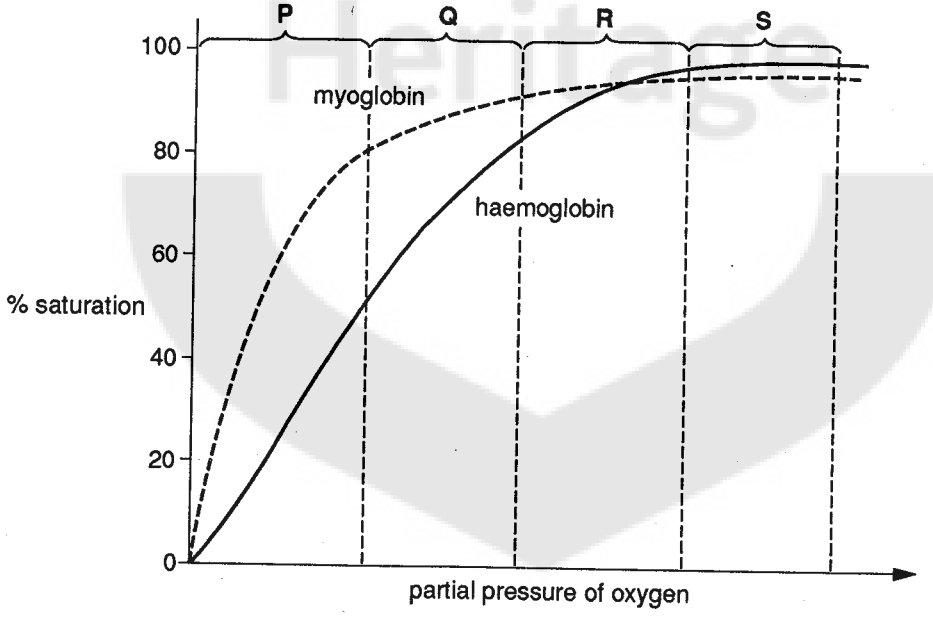
33 The table shows measurements made on a person at rest and during exercise.

	resting	*exercising*
tidal volume	0.5 dm^3	1.0 dm^3
breathing rate	16 min^{-1}	30 min^{-1}
O_2 inspired	21.0%	21.0%
O_2 expired	17.0%	12.0%

What volume of oxygen is absorbed each minute by the person during rest and exercise?

	O_2 absorbed during rest/dm^3	*O_2 absorbed during exercise*/dm^3
A	0.32	0.72
B	0.32	2.7
C	2.0	9.0
D	4.0	9.0

Questions **34** and **35** refer to the graph which shows the oxygen dissociation curves for haemoglobin and myoglobin.



34 Over which range of partial pressures will both myoglobin and haemoglobin release oxygen to respiring tissues at the greatest rate?

A P **B** Q **C** R **D** S

35 What conclusion about myoglobin can be made from the graph?

A It binds one oxygen molecule but haemoglobin binds four oxygen molecules.
B It will donate oxygen to haemoglobin.
C It will only release oxygen when the partial pressure is low.
D It will pick up oxygen less readily than will haemoglobin after exercise.

[Turn over

36 Potassium cyanide is known to interfere with the formation and use of ATP in cell metabolism.

If the use of potassium cyanide resulted in an accelerated entry of a solute into a cell, it may be reasonably assumed that, under normal circumstances, the solute enters by

A active transport.
B osmosis.
C passive diffusion.
D pinocytosis.

37 What does an increase in the secretion of insulin produce?

A a decrease in glucose metabolism
B an increase in blood sugar level
C an increase in glucose permeability of cells
D an increase in the conversion of glycogen to glucose

38 Four events in the transmission of nerve impulses across synapses are:

1 depolarisation of the presynaptic membrane
2 propagation of postsynaptic action potential
3 hydrolysis of transmitter substance
4 rupturing of synaptic vesicles

In which sequence do these events occur?

	first ⟶ *last*			
A	1	3	2	4
B	1	4	2	3
C	4	1	3	2
D	4	3	1	2

39 Removal of the thyroid gland from an adult human would cause an increase in the rate of

A basal metabolism.
B conversion of glycogen to glucose.
C excretion of sodium ions from the kidney.
D secretion of thyroid stimulating hormone.

40 In mammals, glucose is present in blood plasma but not in urine. This is because glucose molecules are

A actively transported from the proximal convoluted tubule.
B oxidised to supply energy for ultrafiltration.
C stored in the kidney.
D too large to enter Bowman's capsule.

Candidate Name _____

Centre Number	Candidate Number

UNIVERSITY OF CAMBRIDGE LOCAL EXAMINATIONS SYNDICATE

General Certificate of Education Advanced Level

BIOLOGY 9260/2, 9261/2

PAPER 2

Thursday **9 JUNE 1994** Afternoon 1 hour 30 minutes

Additional materials:
Answer paper

TIME 1 hour 30 minutes

INSTRUCTIONS TO CANDIDATES

Write your name, Centre number and candidate number in the spaces at the top of this page and on all separate answer paper used.

Section A

Answer **all** questions.

Write your answers in the spaces provided on the question paper.

Section B

Answer **one** question.

Write your answer on the separate answer paper provided.

Your answer should be illustrated by large, clearly labelled diagrams wherever suitable.

At the end of the examination, fasten the separate answer paper securely to the question paper.

INFORMATION FOR CANDIDATES

The intended number of marks is given in brackets [ ] at the end of each question or part question.

In addition, up to 2 marks in Section B are awarded for quality of expression.

FOR EXAMINER'S USE	
Section A	
Section B	
TOTAL	

This question paper consists of 9 printed pages and 3 blank pages.

[Turn over

Section A

Answer **all** the questions in this section.

1 An inherited disease in humans, which results in muscle paralysis, is caused by a dominant mutant allele of the gene coding for a sodium ion channel protein found in the cell surface membrane of skeletal muscle. Sequencing of DNA from normal and affected individuals has shown that the mutation is due to a single base substitution. This results in the amino acid methionine being replaced by valine in the segment of the protein that forms the channel.

Fig. 1 shows the base sequence analysis of the relevant part of the DNA from an affected individual.

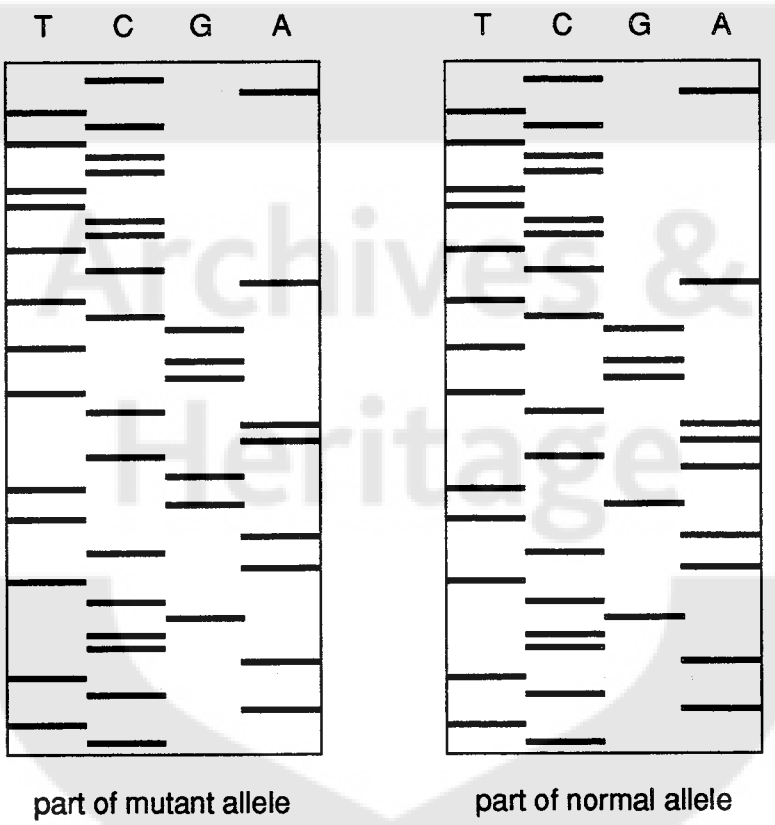


Fig. 1

(a) From the sequence in Fig. 1, identify

(i) the base that is missing in the abnormal sequence;

.....

(ii) the base that has been put in its place.

.....[2]

(b) Explain why changing a single base in the gene coding for a protein may have a major effect on the properties of a protein.

.....

.....

.....

.....

.....[3]

(c) Suggest why single base substitutions do not always have such a major effect on protein structure.

.....

.....

.....[2]

(d) **(i)** In the space below, draw a diagram showing a channel protein in a cell membrane.

(ii) State how the protein is held in the membrane.

.....

.....[3]

2 Fig. 2 shows the changes that occur in the left side of the mammalian heart during the cardiac cycle.

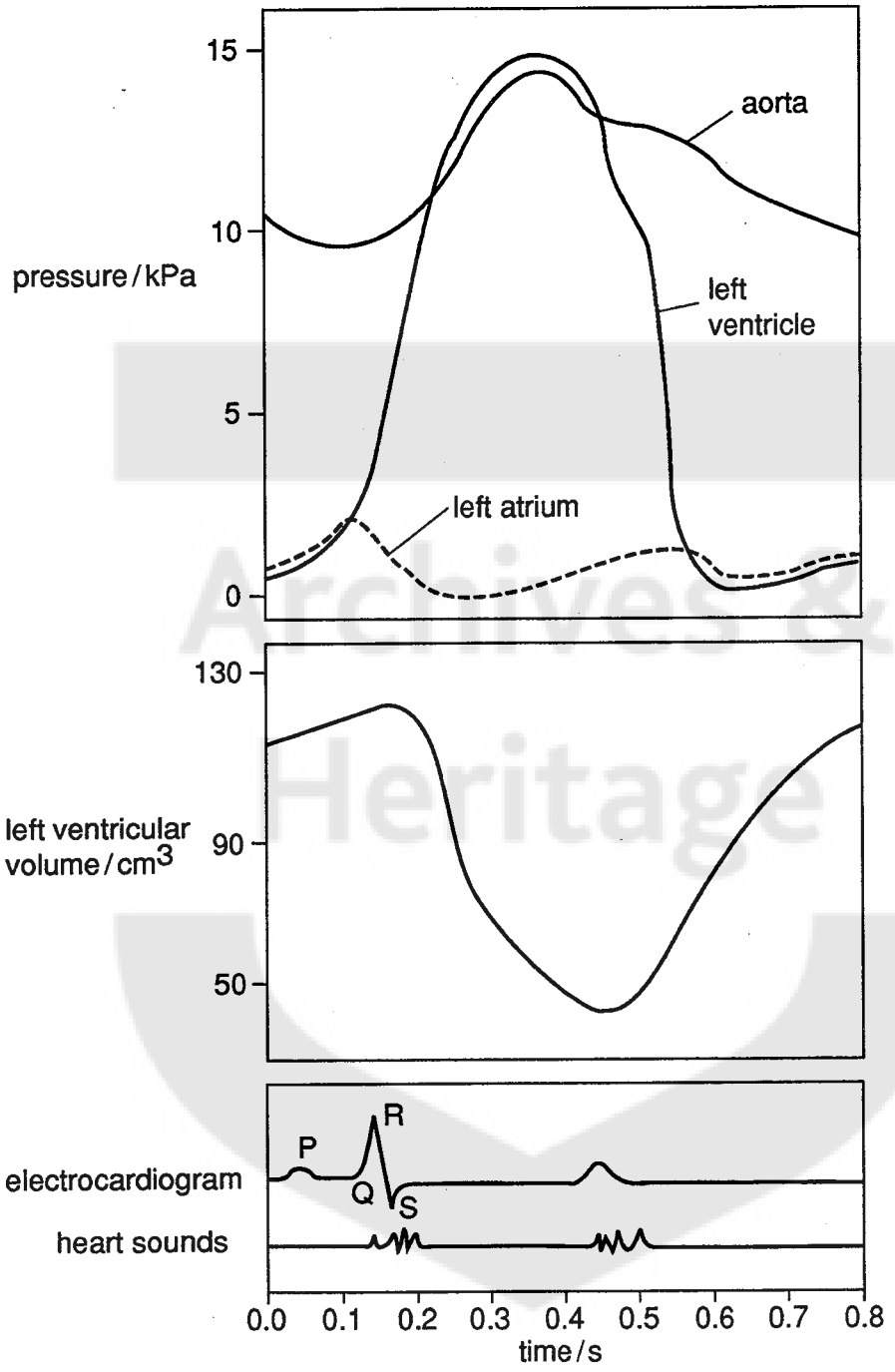


Fig. 2

(a) With reference to Fig. 2 opposite, describe the changes during contraction in the left ventricle of

(i) volume;

.....

.....

.....

(ii) pressure.

.....

.....

.....[4]

(b) Relate the events shown in the electrocardiogram to the activity of the heart (cardiac impulse).

.....

.....

.....[2]

(c) Relate the changes in pressure in the left atrium, left ventricle and aorta, during the cardiac cycle, to the opening and closing of the bicuspid and semi-lunar (aortic) valves.

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.....

.....[4]

(d) Suggest a cause for the heart sounds.

.....

.....[2]

3 Fig. 3 shows how the net primary productivity of the marine alga *Halosphaera viridis*, as measured by oxygen exchange, varies in relation to depth in sea water at 20 °C.

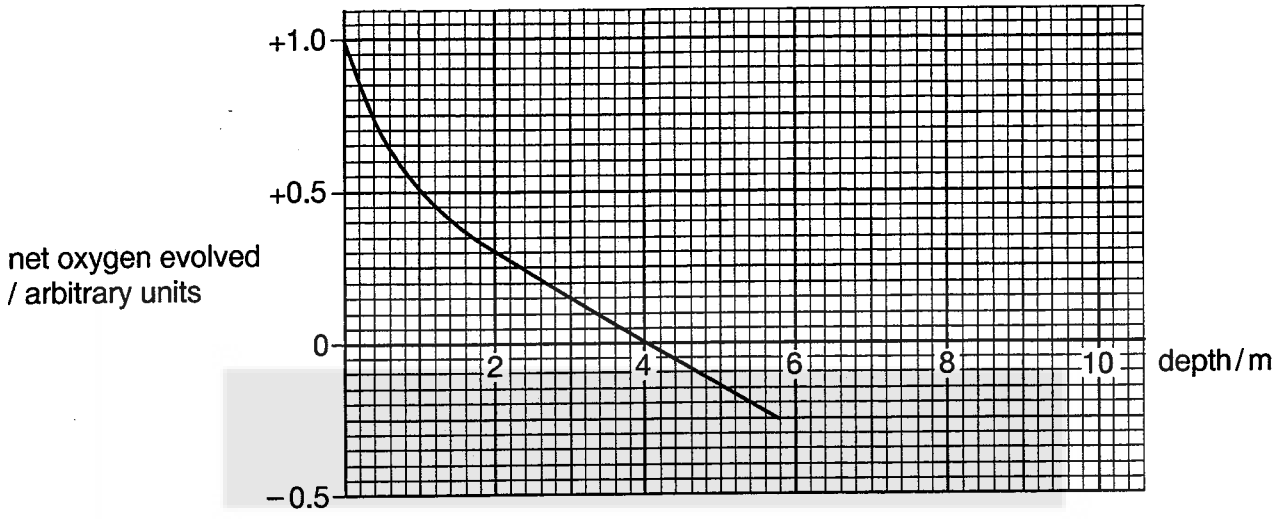

Fig. 3

(a) **(i)** Describe the relationship between net oxygen evolution and depth in *H. viridis* at 20 °C.

.....

.....

(ii) Account for the relationship you have described.

.....

.....[4]

(b) **(i)** What is meant by the term *net primary productivity*?

.....

.....

(ii) Why can net oxygen evolution be used to measure net primary productivity?

.....

.....[4]

(c) Mark with a cross on the curve in Fig. 3 the position of the compensation point. [1]

4 Coat colour in cats is determined by a sex-linked gene with two alleles, black and ginger. When black cats are mated with ginger cats, the female progeny are always tortoiseshell, their coats showing a mottling of small black and ginger patches, while the male progeny have the same coat colour as their mothers.

(a) Using suitable symbols, construct genetic diagrams to explain these results.

Genetic diagrams

[5]

(b) State the phenotypes and genotypes of the progeny that may result from mating a tortoiseshell female with a black male.

.....

.....

.....

.....

.....[4]

5 Read the passage carefully and then answer the questions that follow.

The flat periwinkles, *Littorina obtusata* and *Littorina mariae*, are two closely related marine snails that live on rocky sea shores around the coasts of the British Isles. On sheltered shores, *L. obtusata* is found mainly on the mid-shore on the seaweed *Ascophyllum nodosum* on which it feeds. *L. mariae* occurs on the lower shore on the seaweed *Fucus serratus*, feeding on the microscopic plants living on the surface of the seaweed.

The two species probably diverged from a common ancestor and they now differ markedly in both the size and colour of their shells. *L. obtusata* live for 3 – 4 years breeding more than once. Their shells are larger (15-17 mm) and usually green. *L. mariae* live for one year, breed only once, their shells are smaller (9-12 mm) and usually yellow. *L mariae* living lower on the shore is susceptible to greater predation pressure than *L. obtusata* on the mid-shore. This is due to the larger numbers of crabs which have longer foraging times on the lower shore compared to the mid-shore because of the tidal cycle.

On the lower shore, natural selection favours the annual life cycle of *L. mariae* with early maturity, rapid reproduction and short life-span. On the mid-shore, *L. obtusata* has slow development, delayed reproduction and relatively long life-span. This species is prevented from extending its zone downwards by predation on the lower shore.

(a) Explain why there are no *L. mariae* larger than 12 mm found on the shore.

.....

.....[2]

(b) Suggest why shell colour may be significant in avoiding predation.

.....

.....[2]

(c) Describe the role of natural selection in maintaining *L. mariae* as a separate species from *L. obtusata*.

.....

.....

.....

.....

.....[4]

(d) Suggest a reason for the absence of

(i) *L. mariae* from the mid-shore;

.....

.....

(ii) *L. obtusata* from the lower shore.

.....

.....[2]

Section B

Answer **one** question on the separate sheets of paper provided.

6 **(a)** Outline the methods of preparation of a sample of tissue for examination with the electron microscope. Explain why each stage in the preparation is necessary. [8]

(b) Explain briefly how an image of cell ultrastructure is formed by the electron microscope. [4]

(c) Discuss the advantages and disadvantages of transmission electron microscopy compared to light microscopy. [6]

7 **(a)** Outline the main features of the kidney nephron. Include in your account structural details of the regions of ultrafiltration and selective reabsorption. [8]

(b) Explain how the mammalian kidney produces urine that is hypertonic to the blood. [6]

(c) Describe how the nephron regulates the pH of the blood. [4]

8 **(a)** Describe the techniques that may be used to study a **named** habitat. [10]

(b) Using a **named** example, explain how the habitat of an organism differs from its niche. [4]

(c) Discuss why pyramids of energy are important to the understanding of energy flow through ecosystems. [4]

Centre Number	Candidate Number

Candidate Name _____

UNIVERSITY OF CAMBRIDGE LOCAL EXAMINATIONS SYNDICATE

General Certificate of Education Advanced Level

BIOLOGY 9260/3

PAPER 3

Wednesday **15 JUNE 1994** Morning 2 hours 30 minutes

Additional materials:
Answer paper
Ruler (cm/mm)

TIME 2 hours 30 minutes

INSTRUCTIONS TO CANDIDATES

Write your name, Centre number and candidate number in the spaces at the top of this page and on all separate answer paper used.

Answer the questions set on **two** of the options.

Within each chosen option, Questions 1 and 2 are to be answered in the spaces provided on the question paper. Question 3 is to be answered on the separate answer paper provided.

The answer to Question 3 should be illustrated by large, clearly labelled diagrams wherever suitable.

At the end of the examination,

(a) fasten the separate answer paper securely to the question paper;

(b) enter the numbers of the options you have answered in the grid below.

INFORMATION FOR CANDIDATES

The intended number of marks is given in brackets [ ] at the end of each question or part question.

In addition, up to 2 marks in Question 3 are awarded for quality of expression.

The options are:

1 – Diversity of Organisms (page 2)
2 – Applied Plant Science (page 10)
3 – Applications of Genetics (page 15)
4 – Growth, Development and Reproduction (page 19)

OPTIONS ANSWERED		
FOR EXAMINER'S USE		
1		
2		
3(a)		
3(b)		
TOTAL		

This question paper consists of 21 printed pages and 3 blank pages.

[Turn over

OPTION 1 – DIVERSITY OF ORGANISMS

1 Fig. 1 shows the percentage of light transmitted per metre through clear oceanic water and through cloudy (turbid) coastal water.

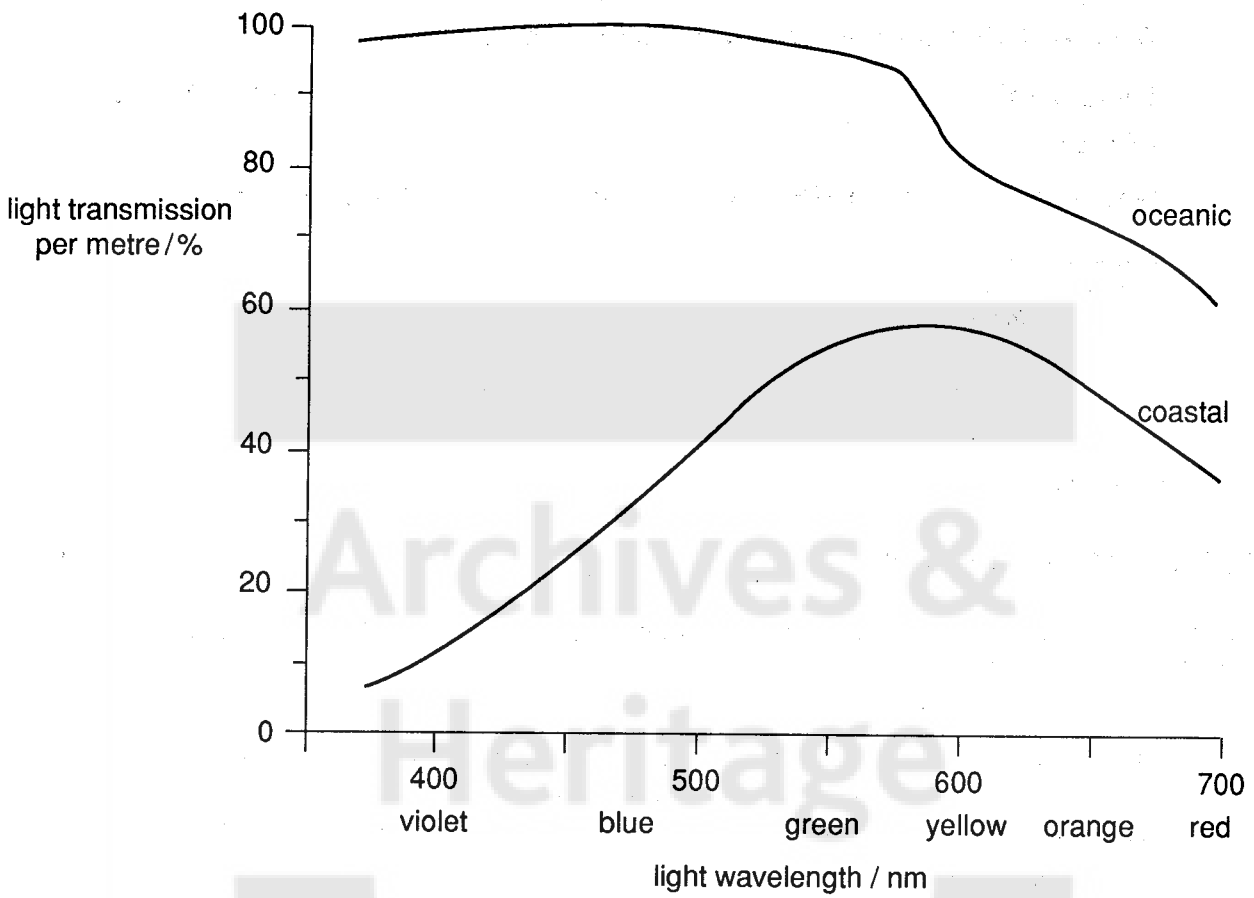

Fig. 1

(a) With reference to Fig. 1,

(i) describe how the transmission of light differs in oceanic and coastal waters;

.....

.....

.....

.....

.....

(ii) state whether oceanic or coastal water would allow algae to grow to a greater depth. Give a reason for your answer.

.....

.....

.....[6]

Fig. 2 shows the ranges of depth at which ten species of green algae and ten species of brown algae were found in an area of clear oceanic water.

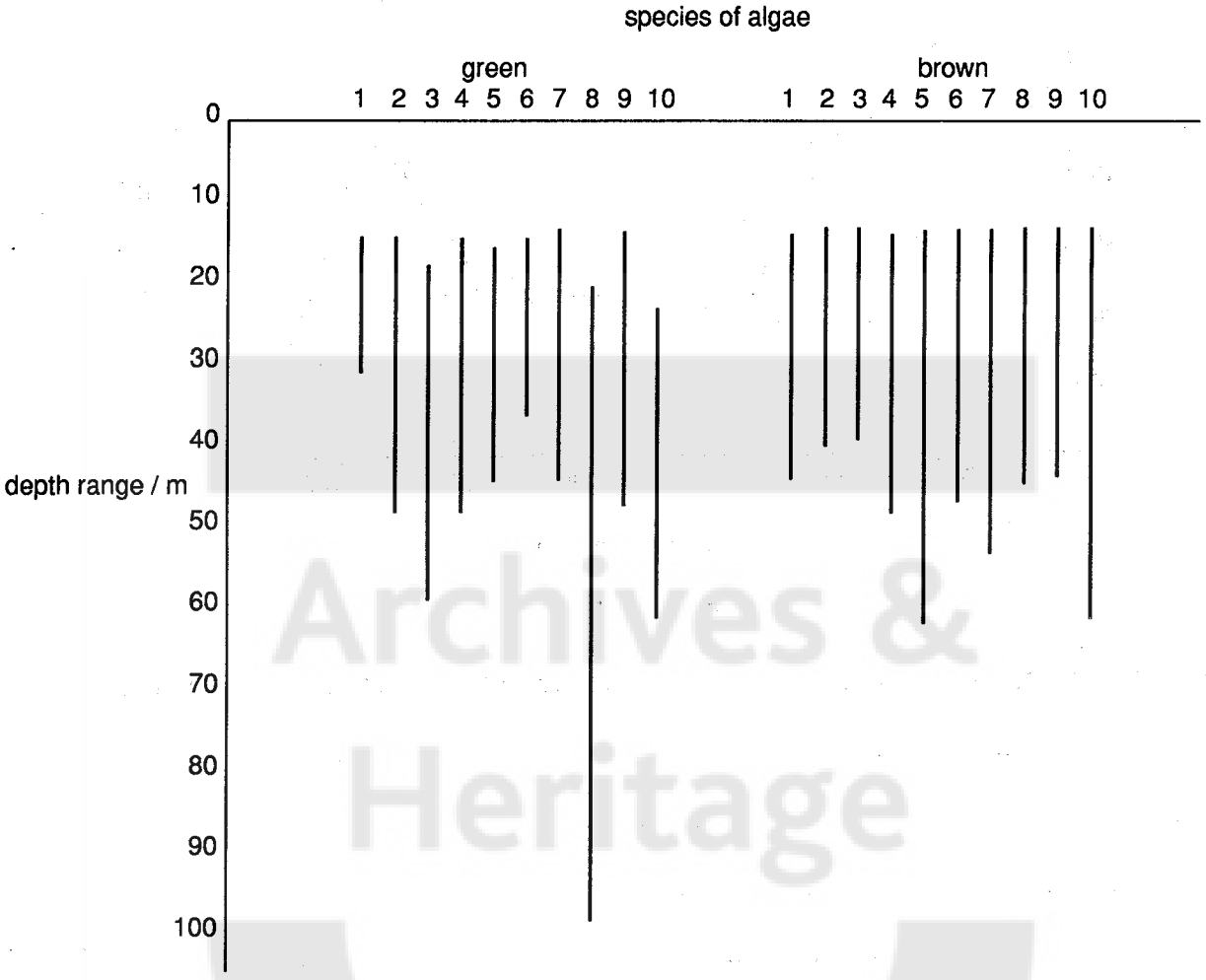

Fig. 2

(b) To what extent do these data support the hypothesis that brown algae are able to grow in deeper water than green?

.....

.....

.....[2]

Fig. 3 shows the absorption spectra for a brown and a green alga.

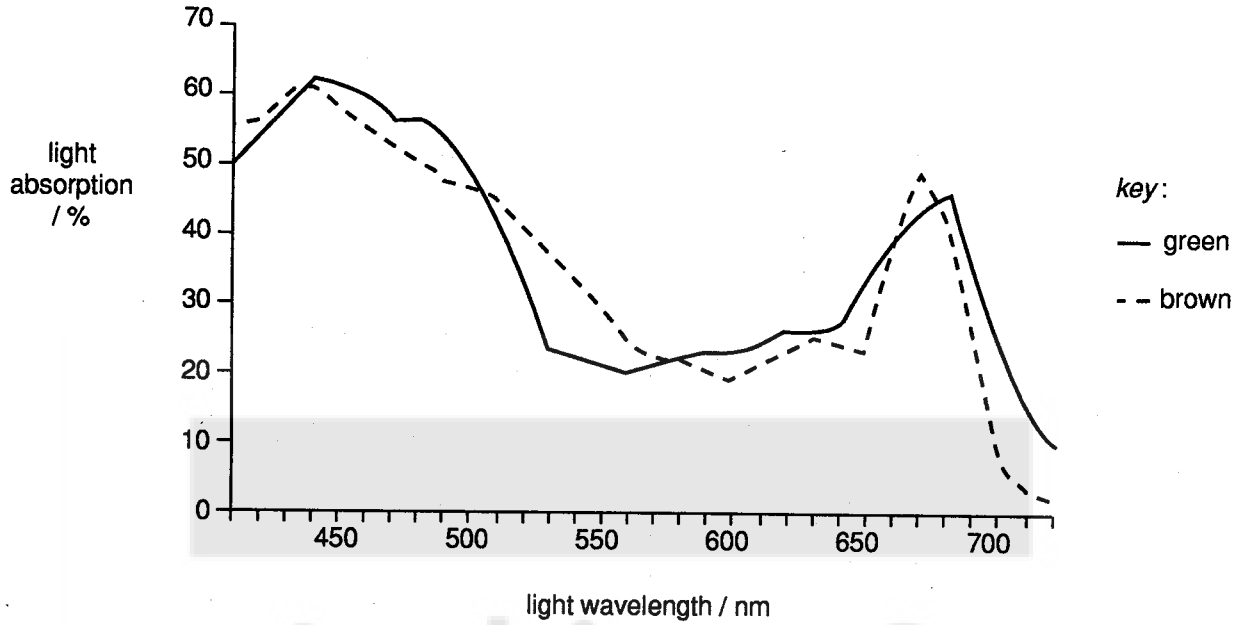

Fig. 3

(c) Give reasons for the similarities and differences between the two absorption spectra.

.....

.....

.....

.....[3]

Many algae have a high protein content, approaching 60% of dry mass in some species.

(d) Suggest **one** possible benefit from each of the following:

(I) spreading seaweed onto farmland to decompose;

.....

.....

.....

(II) inclusion of algae in the human diet in place of fish.

.....

.....

.....[4]

[Total: 15]

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PLEASE TURN OVER FOR QUESTION 2.

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2 **(a)** State the approximate size of each of the following:

a virus .....

a fern gametophyte .....

a fungal hypha (diameter) .....[3]

Fig. 4 is an electronmicrograph of a bacterium.

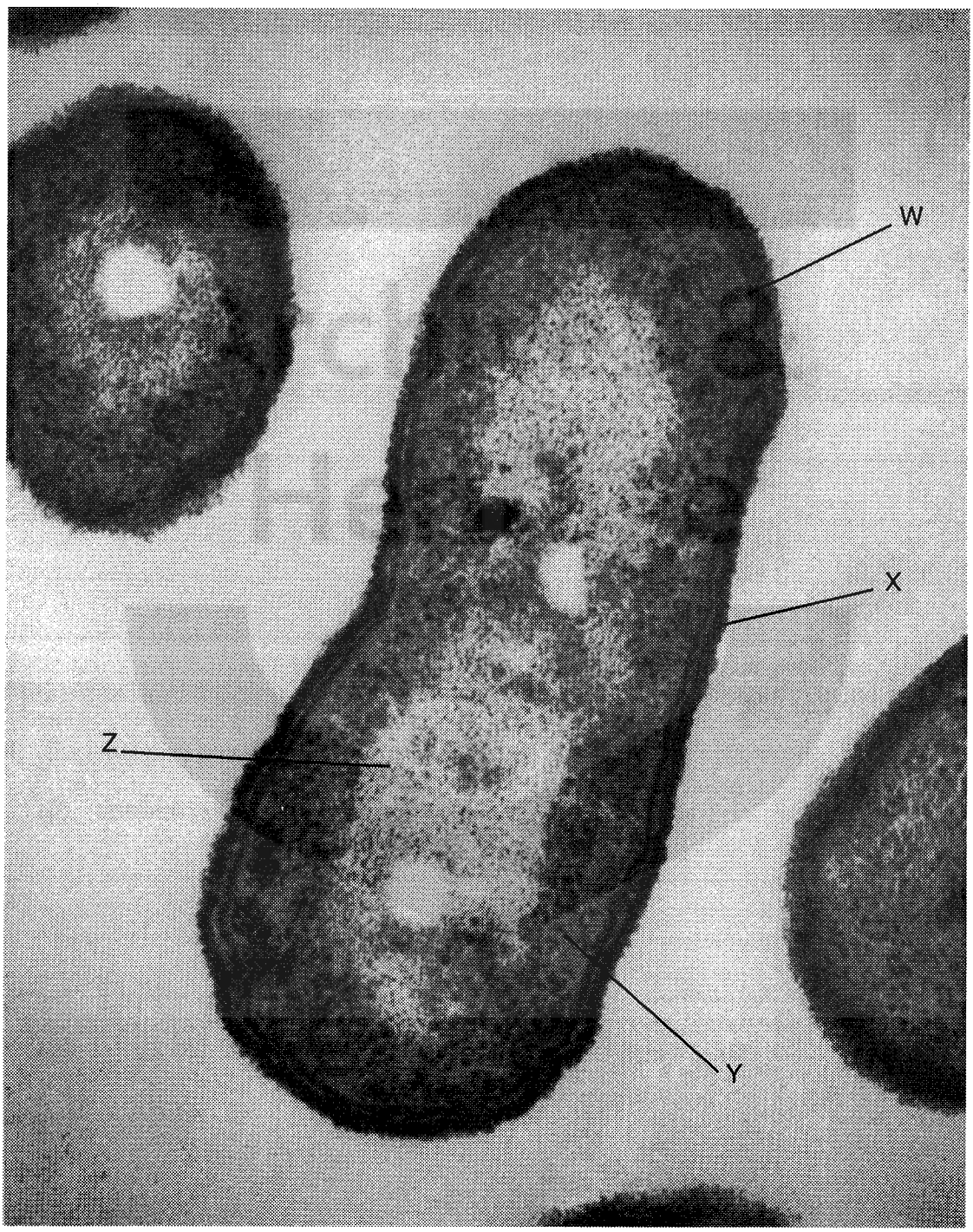


Fig. 4

(b) **(i)** Name structures **W**, **X**, and **Y**.

W .....

X .....

Y .....

(ii) Suggest **one** structure that may be found in the region labelled **Z**.

.....

[2]

(c) Calculate the actual length of the bacterium in Fig. 4. Show your working.

.....

.....

.....[2]

Fig. 5 shows part of a leguminous plant (a type of herbaceous dicotyledon).

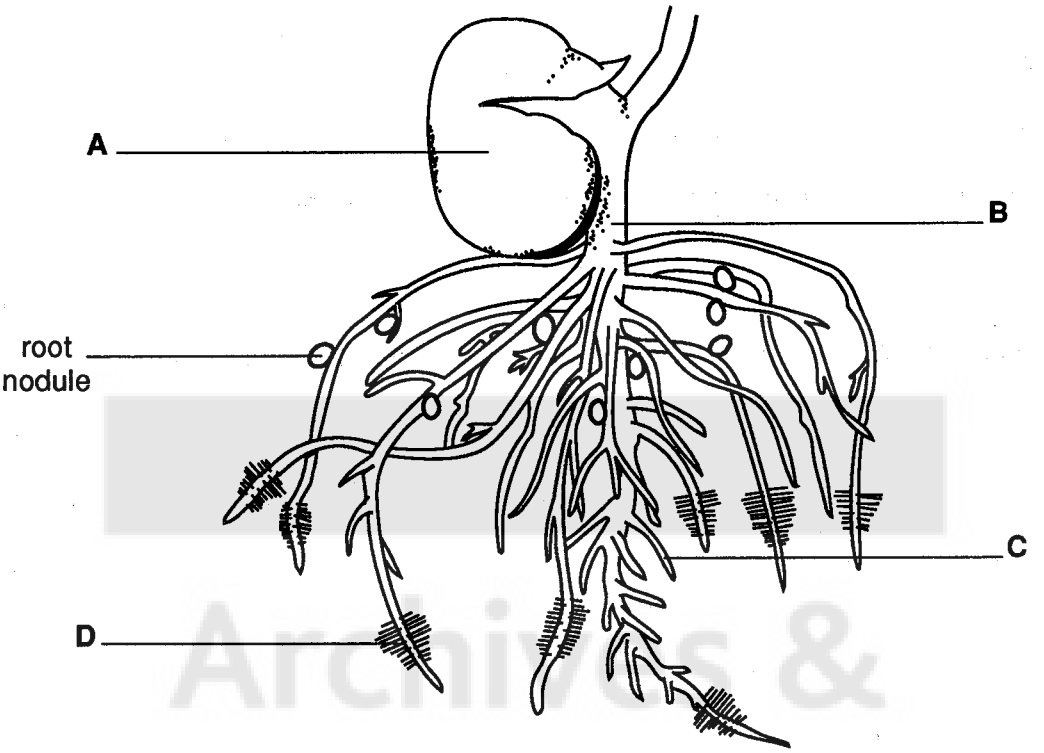


Fig. 5

(d) Name the structures labelled **A** to **D**.

A .....

B .....

C .....

D .....

[2]

(e) Complete the table below by stating **four** differences between cells of a leguminous plant and bacterial cells.

	Feature	Plant	Bacterium
1	.....	.....	.....
	.....	.....	.....
2	.....	.....	.....
	.....	.....	.....
3	.....	.....	.....
	.....	.....	.....
4	.....	.....	.....
	.....	.....	.....

[4]

Root nodules in leguminous plants contain nitrogen fixing bacteria.

(f) What is the benefit of these bacteria to farmers and gardeners?

.....

.....

.....

.....

.....[2]

[Total: 15]

3 Either

(a) (i) List the external features that distinguish mammals from other chordates. [3]

(ii) Describe the specialised features for gas exchange in a **named** mammal. [12]

(iii) Suggest what the presence of gill slits in the embryos of all chordates indicates about members of the phylum. [3]

Or

(b) (i) Describe the external features of an earthworm. [4]

(ii) Describe the triploblastic organisation of a coelomate, stating why such an organisation is advantageous to the earthworm. [10]

(iii) Suggest why the habitat of most annelids is either soil or water. [4]

[Turn over

OPTION 2 – APPLIED PLANT SCIENCE

1 At the end of the growing season a cereal crop, such as barley, consists of leaves, stems and the grain-bearing ears. The grain is the marketable proportion and it forms 40% of the crop at harvest. Two features of the ears determine the final yield:

1. ear population = number of ears per metre of drill row;
2. ear size = number of grains per ear.

The ear population depends on the original sowing density and the number of side-shoots that develop from the base of the plants during their early growth.

A variety of barley (Zephyr) was grown under uniform conditions of cultivation for five consecutive years; the yields were analysed with the results shown in Table 1.

Table 1

	Year					Mean
	1968	1969	1970	1971	1972	
grain yield /tonne ha^{-1}	3.5	4.8	4.5	3.1	5.7	4.3
ear population/ no. m^{-1} drill row	96	93	146	98	111	108.8
ear size/grains ear^{-1}	20	20	13	20	22	19.0

(a) (i) Comment on the grain yields in 1969 and 1970 on the basis of the figures given in Table 1.

.....

.....

.....

(ii) Calculate the total crop biomass in tonnes per hectare in 1972. Show your working.

.....

.....

.....

(iii) Suggest **two** reasons for the fluctuations in yield during this five-year study.

1. .....

.....

2. .....

.....

[5]

In another study, the effects of nitrogen fertiliser and cultivation techniques on grain yield were investigated. The fields chosen for the study were either ploughed deeply or were not ploughed at all. In the latter case, the barley seed was drilled directly into the soil with the minimum of cultivation. Each field was subdivided into four areas. Nitrogen fertiliser was applied to three of these areas at different rates; one area received no fertiliser at all. The yields of barley for each area were analysed and the results are shown in Table 2.

Table 2

	Cultivation method	Nitrogen fertiliser applied/kg ha^{-1}			
		0	50	100	150
grain yield /tonne ha^{-1}	deep ploughing	2.6	4.4	5.7	5.6
	direct drilling	1.8	3.0	3.9	4.9
ear population/ no. m^{-1} drill row	deep ploughing	65	87	111	123
	direct drilling	40	69	86	102
ear size/grains ear^{-1}	deep ploughing	18	22	22	22
	direct drilling	20	21	21	23

(b) With reference to Table 2, describe the effects on the growth and yield of barley of

(i) the two cultivation techniques;

.....

.....

.....

.....

(ii) the added nitrogen fertiliser.

.....

.....

.....

.....

[6]

(c) State **two** functions of nitrogen in plants.

1. .....

.....

2. .....

.....

[2]

(d) Give **two** advantages of direct drilling of crops.

1. .....

.....

2. .....

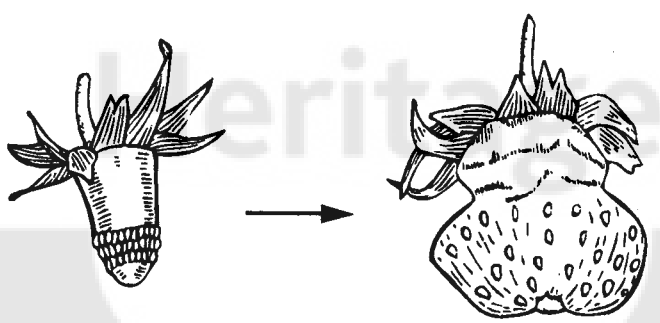
.....

[2]

[Total: 15]

2 The initial development of the receptacle, which forms the soft part of the strawberry fruit, is stimulated by auxins released by pollen tubes. If the flower is not fertilised then an abscission layer forms at the base of the flower stalk, which then breaks under the slightest strain. Pollen tubes do not persist for long after fertilisation, but the receptacle continues to swell.

In an experiment designed to find the source of the auxin which stimulates further fruit growth, all but three rows of developing ovaries were removed from a young strawberry. The fruit was left attached to the parent plant and continued to grow, but in an abnormal fashion as shown in Fig. 6.



strawberry with all but three rows of developing ovaries removed

after 2 weeks growth

Fig. 6

(a) **(I)** Explain how this result suggests that the source of auxin lies within the fruit rather than somewhere in the rest of the plant.

.....

.....

.....

(II) Suggest a suitable control for the experiment shown in Fig. 6.

.....

.....

.....

(iii) Outline **one** further experiment to show that auxins stimulate the growth of strawberry fruits.

.....

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.....[6]

Auxins also stimulate fruit growth in orchard crops such as peaches. Fig. 7 shows the concentration of an auxin, indole acetic acid (IAA), in fruits of a peach variety and the incidence of abscission (number of fruit falling per day). Any ripe fruits that fall before harvest are of no commercial value.

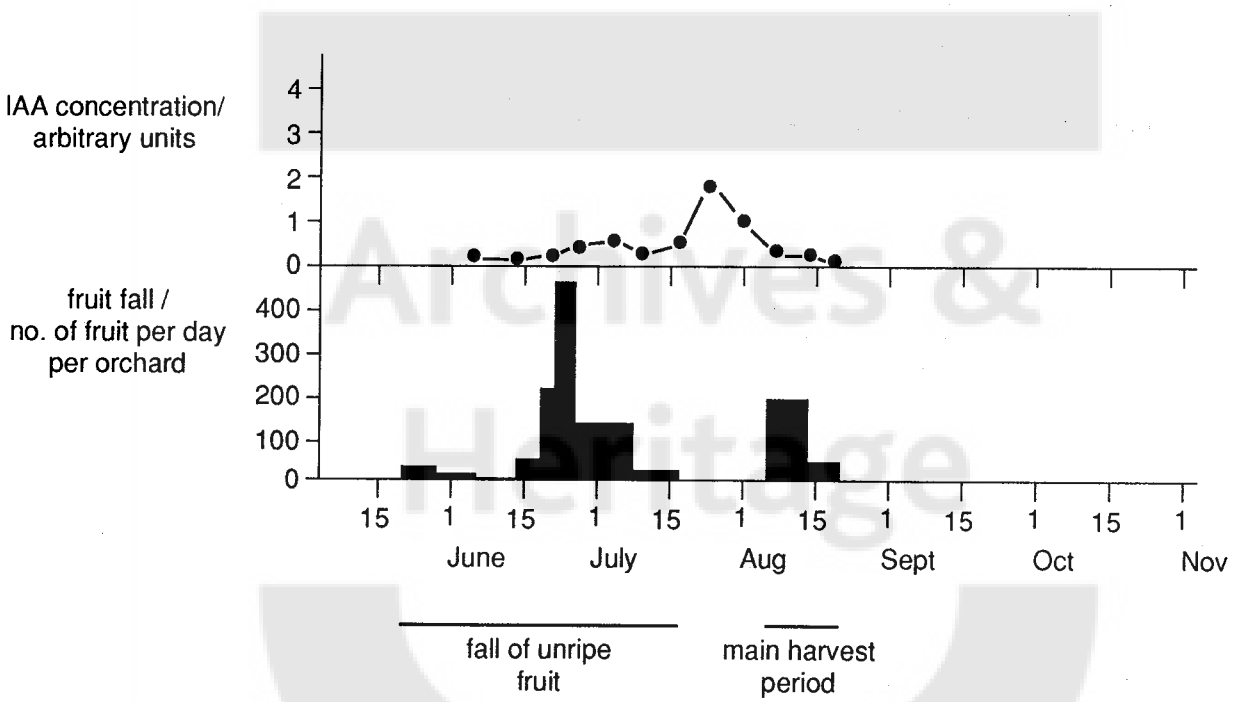

Fig. 7

(b) With reference to Fig. 7,

(i) describe the pattern of fruit fall;

.....

.....

.....

.....

(ii) comment on the relationship between IAA concentration and fruit fall.

.....

.....

.....

(iii) Suggest **two** advantages of spraying orchards with a synthetic auxin such as naphthalene acetic acid (NAA).

1. .....

.....

2. .....

.....

[7]

Synthetic auxins are also used by growers in the following ways:

A. to prevent sprouting of potatoes during storage;

B. to initiate root growth in cuttings.

(c) Explain **one** commercial advantage of each of these uses.

A. .....

.....

B. .....

.....

[2]

[Total: 15]

3 Either

(a) (i) Describe the processes involved in the movement of water from the stem of a plant, through the leaf to the atmosphere. [9]

(ii) Explain how turgor changes lead to the movement of guard cells. [4]

(iii) Discuss the possible effects of stomatal behaviour on the productivity of field crops. [5]

Or

(b) (i) Outline the reasons for controlling weeds. [8]

(ii) Discuss the ways by which weeds can be controlled and assess the advantages and disadvantages of each method. [10]

OPTION 3 – APPLICATIONS OF GENETICS

1 Concern about the widespread use of broad-spectrum chemical insecticides has led to research into biopesticides. Viruses provide alternatives to chemicals for controlling insect pests. They can be applied to plants by spraying and are specific to the pest, or have a limited range of hosts. When taken up by insect larvae the viruses enter cells and begin to replicate. This causes tissue damage and death of the larvae.

(a) Suggest what is meant by the term *biopesticide*.

.....

.....[1]

One reason for concern about the use of chemical insecticides is that they lead to the development of resistance.

(b) Outline briefly how resistance to an insecticide

(i) arises;

.....

.....

(ii) spreads in an insect population.

.....

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.....

.....

[4]

Female mites of the species *Pyemotes tritici* inject an extremely potent venom into their prey and are able to paralyse insects 150 000 times their size. The DNA coding for three different polypeptide components of this toxin has been cloned and incorporated into a virus which can infect insects. These genes are expressed when the recombinant virus infects an insect.

Fig. 8 shows the effects of infecting one batch of newly emerged insect larvae (*Trichoplusia*) with recombinant virus and another batch with non-engineered virus. A third batch was left uninfected and showed a mortality of 4% after 6 days.

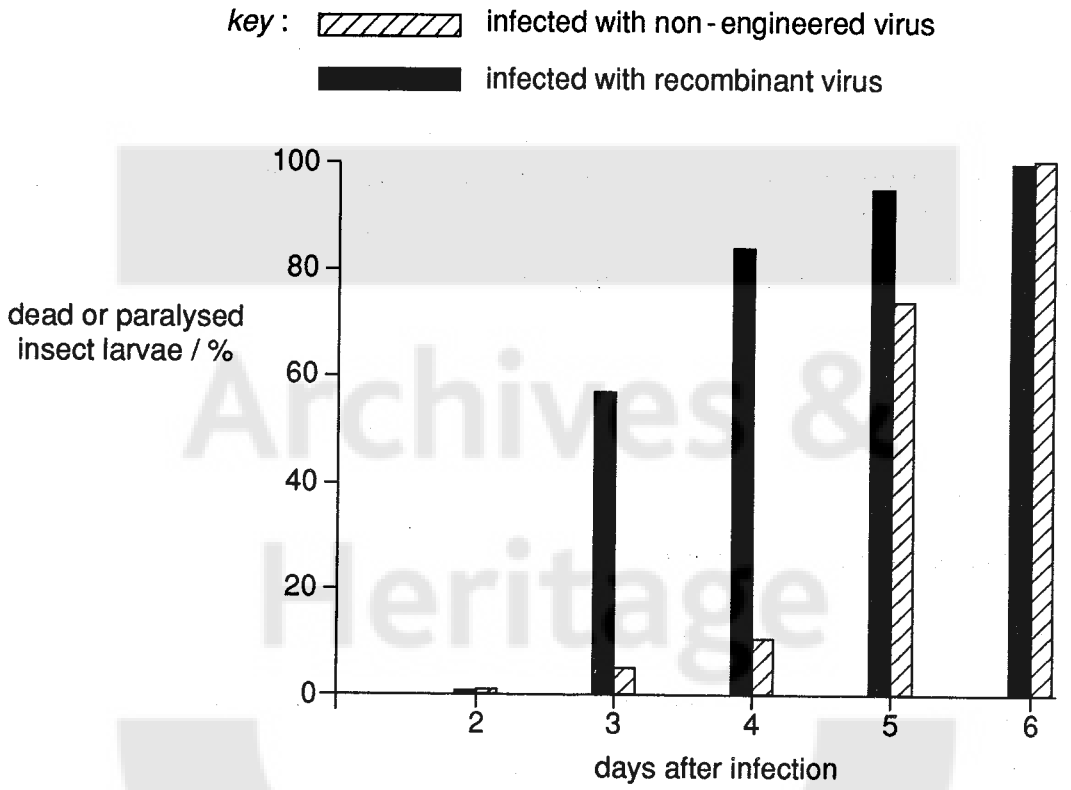

Fig. 8

(c) Explain why one batch of larvae was left uninfected.

.....

.....[1]

(d) Compare the effects of infecting *Trichoplusia* larvae with recombinant virus and with non-engineered virus.

.....

.....

.....

.....

.....

.....[4]

(e) List the steps by which a gene for a polypeptide toxin from a mite could be incorporated into a virus.

.....

.....

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.....

.....

.....[5]

[Total: 15]

2 In the inheritance of feather colour in chickens there is an interaction between two autosomal gene loci, **I/i** and **C/c**. Individuals carrying the dominant allele, **I**, have white plumage even if they also carry the dominant allele, **C**, for coloured plumage.

(a) State the term that is applied to this type of interaction.

.....[1]

(b) List the genotypes that will result in coloured plumage.

.....[1]

White Leghorn chickens have the genotype **IICC**, whilst white Wyandotte chickens have the genotype **iicc**. A white Leghorn is crossed with a white Wyandotte.

(c) Draw a genetic diagram in the space below to show the expected genotypes and phenotypes and their ratios in the F_1 and F_2 generations.

Genetic diagram

[9]

(d) Suggest an explanation for the interaction between the two gene loci.

.....

.....

.....

.....

.....[4]

[Total: 15]

3 Either

(a) (i) Explain the advantages and disadvantages of the use of artificial insemination (AI) in animal breeding. [10]

(ii) Discuss the implications of the use of AI in humans. [8]

Or

(b) (i) Explain what is meant by *variance*. [4]

(ii) Explain with examples how geneticists decide what proportion of the variation in a character is inherited. [10]

(iii) Outline the significance of existing variation to the breeding of new varieties. [4]

For Examiner's Use

OPTION 4 – GROWTH, DEVELOPMENT AND REPRODUCTION

1 The comparative growth patterns of leaves, roots, flower stem and ear (grain) in darnel grass (*Lolium temulentum*) are shown in Fig. 9. Arrows indicate the onset of inflorescence initiation (**I**) and ear emergence (**E**). Dry mass was used to measure growth over a period of thirteen weeks.

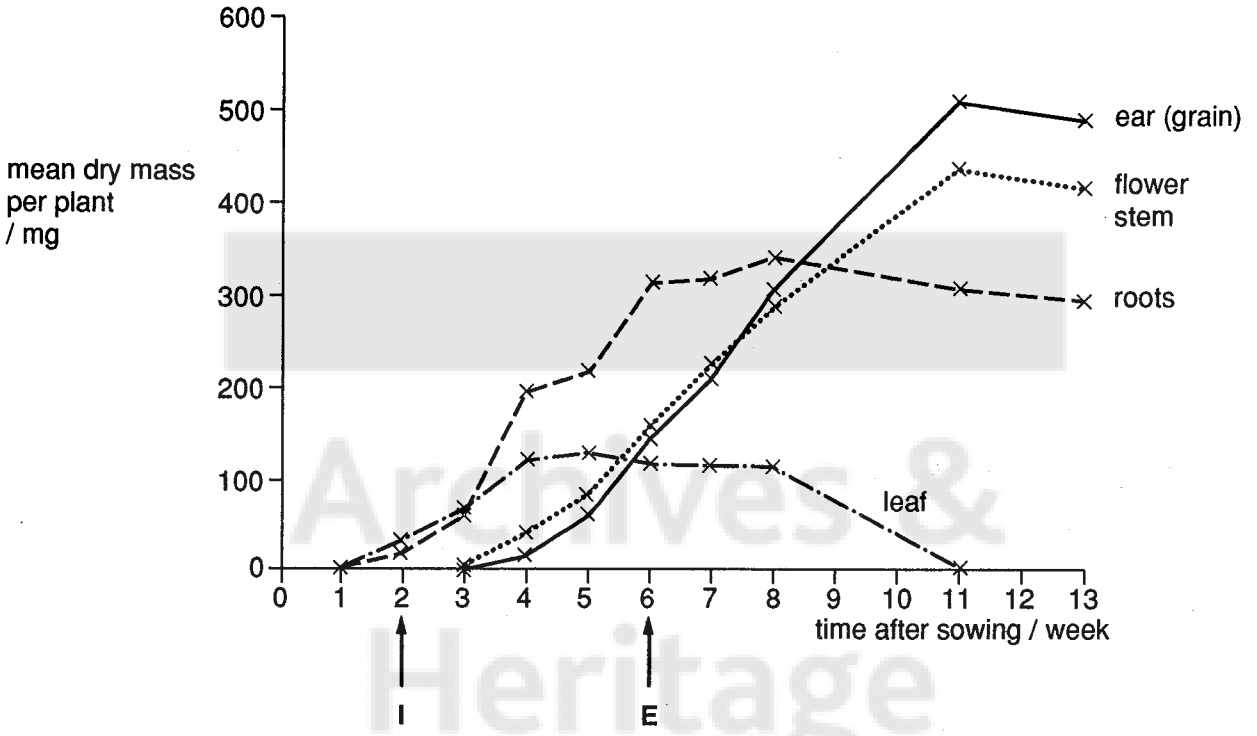

Fig. 9

(a) With reference to Fig. 9,

(i) describe the growth of the leaves and the roots of darnel grass;

leaves .....

.....

.....

roots .....

.....

.....

(ii) suggest how the patterns of growth shown by the flower stem and the ear are related to the growth pattern of the leaves.

.....

.....

.....

.....

[5]

[Turn over

(b) (i) Outline a method that could be used to measure the dry masses of the constituent parts of the darnel grass plants.

.....

.....

.....

.....

.....

.....

.....

.....

.....

(ii) State a major disadvantage of the procedure.

.....

.....

[5]

(c) (i) Darnel grass is a long day plant. Outline a possible sequence of events by which flowering could be initiated.

.....

.....

.....

.....

.....

.....

(ii) Suggest, with reasons, whether darnel grass would be expected to flower if grown in equatorial regions.

.....

.....

.....

.....

.....

[5]

[Total: 15]

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PLEASE TURN OVER FOR QUESTION 2.

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2 *Read the passage below and answer the questions that follow.*

The anterior pituitary gland secretes two hormones that regulate the activity of the ovary and the testis; these are follicle stimulating hormone (FSH) and luteinising hormone (LH), collectively called gonadotrophins. Both FSH and LH are glycoproteins. They are secreted from the gonadotrophic cells, in response to gonadotrophin-releasing hormone (G_nRH). This is released by neurosecretion from the hypothalamus into the portal system which delivers G_nRH directly to the gonadotrophic cells.

The pattern and amount of G_nRH release is under the control of two mechanisms; a hypothalamic 'clock' that sets the duration of the cycle and the timing of major events, and the negative feedback effects of sex hormones on the hypothalamus and the anterior pituitary gland.

G_nRH, FSH and LH act, in very low concentrations, on their target organs by combining with specific surface receptor molecules in the cell surface membrane. Once activated the receptor molecules increase the concentration of adenyl cyclase, an enzyme that promotes the formation of cyclic AMP from ATP.

Intracellular cyclic AMP acts as a second messenger binding to a protein kinase which, in turn, transforms many inactive proteins into active enzymes by phosphorylating them.

Illness, malnutrition, severe stress and emotional crises interfere with the operation of the ovarian cycle by acting on higher brain centres.

(a) Explain the following terms.

(i) *gonadotrophins* (line 3)

.....

.....

(ii) *glycoprotein* (line 3)

.....

.....

(iii) *neurosecretion* (line 5)

.....

.....

(iv) *portal system* (line 6)

.....

.....

(v) *negative feedback* (line 9)

.....

.....

[5]

(b) Outline the action of FSH on the ovary and testis.

ovary .....

.....

.....

testis .....

.....

.....

[4]

(c) Suggest which organelles are responsible for the synthesis of LH.

.....

.....[2]

(d) Explain how FSH and LH are able to act independently on their target organs.

.....

.....

.....[1]

(e) Suggest **one** advantage of the gonadotrophic hormones acting indirectly through cyclic AMP as a second messenger.

.....

.....[1]

(f) Suggest why women may suffer from irregular menstruation as a result of stress.

.....

.....

.....[2]

[Total : 15]

3 Either

(a) (i) Outline the role of the apical meristems of the stem and root in producing the primary plant body, and explain how xylem vessels become specialised from meristematic cells. [14]

(ii) Suggest how cells with identical genotypes can form a range of different tissues. [4]

Or

(b) (i) Describe the process of fertilisation in mammals, explaining the origin of genetic diversity in the products. [14]

(ii) Explain how genetic diversity may arise in a plant propagated by vegetative means. [4]

Centre Number	Candidate Number

Candidate Name _____

UNIVERSITY OF CAMBRIDGE LOCAL EXAMINATIONS SYNDICATE

General Certificate of Education Advanced Level

BIOLOGY

9260/5, 9261/6

Practical Test

Tuesday **24 MAY 1994** Morning 2 hours 30 minutes

Candidates answer on the question paper.
Additional materials:
As listed in Instructions to Supervisors

TIME 2 hours 30 minutes

INSTRUCTIONS TO CANDIDATES

Write your name, Centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided on the question paper.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets [ ] at the end of each question or part question.

You should spend the first 15 minutes carefully reading through the whole paper before starting to answer any questions.

You should spend 1 hour 5 minutes on Question 1, 35 minutes on Question 2 and 35 minutes on Question 3.

You may be penalised for recording irrelevant information.

FOR EXAMINER'S USE	
1	
2	
3	
TOTAL	

This question paper consists of 10 printed pages, 1 blank page and a report form.

[Turn over

Question 1 [*65 minutes*]

You are required to investigate some aspects of the respiration of mung bean seedlings using a respirometer set up as shown in Fig. 1.

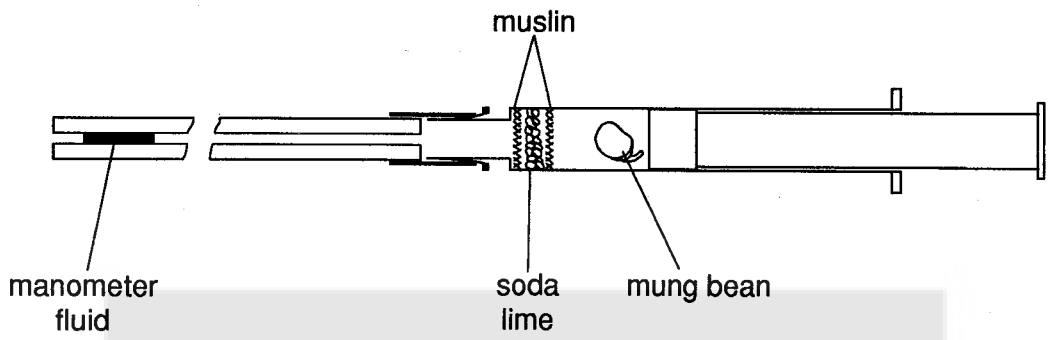

Fig. 1

Set up the respirometer as follows:

Soda lime granules (which are **corrosive**) have been placed inside one of the syringes with which you have been supplied. Remove the plunger from this syringe. Take one of the mung bean seedlings and carefully remove and discard its testa (seed coat). Place the seedling in the syringe barrel as shown. Replace the plunger and push it in until it is about 0.5 cm from the seedling. Check that the syringe is attached securely to the capillary tube. Dip the end of the capillary tube into the manometer fluid provided so that a drop is introduced into the tube. Wipe excess fluid from the tube. The size of the drop of manometer fluid in the capillary tube is not important as long as it can be seen clearly.

Place the respirometer horizontally on the separate piece of graph paper with which you have been provided. Leave it for **three** minutes. Check that the manometer fluid is now moving smoothly towards the syringe. If it is not wait until it does so.

(a) *Without handling the apparatus* measure, in mm, the distance travelled by the manometer fluid in **six** consecutive time intervals, each of **1** minute. Do this by marking the position of the fluid on the graph paper and reading off the distances after the six minute period.

Record these results in the table.

	Minutes					
	1	2	3	4	5	6
Distance travelled in each minute/mm						

Immediately you have recorded your results, detach the syringe from the capillary tube by pulling it gently from the connector. Fit an empty 2 cm^3 syringe to the capillary tube and flush out the manometer fluid onto a piece of filter or blotting paper so that the bore of the capillary tube is empty.

(b) Plot a graph of your results.

(c) **(i)** *Without* quoting any numerical values, explain how this apparatus and procedure allows you to monitor oxygen absorption by the mung bean seedling.

.....

.....

.....

.....

(ii) Suggest an advantage of removing the testa from the seedling before it was placed in the respirometer.

.....

(iii) Calculate the volume of oxygen (in mm^3) which would have been taken up by the mung bean seedling in **one hour** given that:

the diameter of the bore of the capillary tube is 0.4mm,

the formula for the volume of a cylinder is π x radius ^{2}x length. (Take $\pi = \frac{22}{7}$).

Show how you arrive at your answer.

(iv) What assumption about the **rate** of oxygen uptake have you made in the calculation in **(c)(iii)**?

.....

(v) Comment on the validity of the assumption made in **(c)(iv)** by referring to your results in **(a)** and **(b)**.

.....

.....

Return to the syringe containing the mung bean seedling and soda lime. Remove the syringe plunger, and keeping the syringe more or less horizontal, remove the seedling using a pair of forceps. Replace the plunger to approximately its original position in the syringe. Connect the syringe to the capillary tube. Introduce some manometer fluid as before. Place the respirometer on the piece of graph paper.

(d) **(i)** Wait **three** minutes, then measure the distance travelled by the manometer fluid in **three** consecutive time intervals each of 1 minute.

Record these results in the table below.

	Minutes		
	1	2	3
Distance travelled in each minute/mm			

Flush the manometer fluid out of the capillary tube as in **(a)**.

(ii) What information is provided by the results of the procedure in **(d)(i)** which is necessary in order to be able to interpret correctly the readings you took in **(a)**?

.....

.....

.....

(e) **(i)** Place a mung bean seedling (with testa removed) in a 2 cm^3 syringe which does **not** contain soda lime. Attach the syringe to the capillary tube. Introduce fresh manometer fluid. Allow **three** minutes to elapse. Record, in the table, the distance travelled by the manometer fluid in **six** consecutive time intervals, each of 1 minute.

State the *direction* in which any movement occurs e.g. "*towards the syringe*".

	Minutes					
	1	2	3	4	5	6
Distance travelled in each minute / mm						
Direction of movement (if it occurs)						

(ii) Use your biological knowledge to account for the results you have obtained in **(e)(i)**.

.....

.....

.....

(f) Apart from its small size, what is the main *disadvantage* of this type of respirometer?

.....

.....

[25]

For Examiner's Use

Question 2 [*35 minutes*]

K1 is a stained, longitudinal section of the tip of a young root. Use your microscope to find cells at various stages of division (mitosis).

(a) **(i)** Make high power drawings, *to the same scale*, of **four** different cells which illustrate the process of division which occurs in this specimen.

(ii) Briefly annotate your drawings to explain what has taken place in each cell. *Stage names of the process are* **not** *required.*

(iii) Number your drawings from **1** to **4** (**1** being the earliest) to show the sequence involved when this process occurs in an individual cell.

K2 is a stained preparation of the testes of an insect. *You are not expected to have seen this material before.*

Examine **K2** using the low power of your microscope.You will see a number of banana-shaped structures (see Fig. 2). At one end of each of these structures sperm can be identified by their obvious "tails".

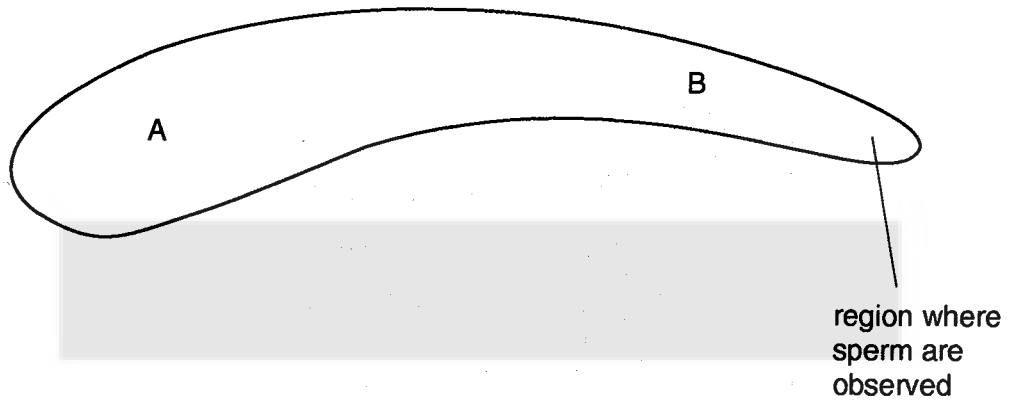

Fig. 2

(b) **(i)** Make a high power drawing to show the shape of the "head" of **one** mature sperm.

(ii) Approximately how many times is the tail longer than the head of a mature sperm?

.....

Different stages in the development of sperm are seen as you scan along these banana-shaped structures from A to B (Fig. 2).

(iii) What are the main genetic changes which occur in such cells during the process of sperm development?

.....

..... [17]

Question 3 [*35 minutes*]

K3 is a stained, transverse section through the small intestine of a mammal. Examine **K3** carefully using your microscope. The layers making up the wall of the organ are shown **diagrammatically** in Fig. 3.

You are not expected to have seen this specimen before.

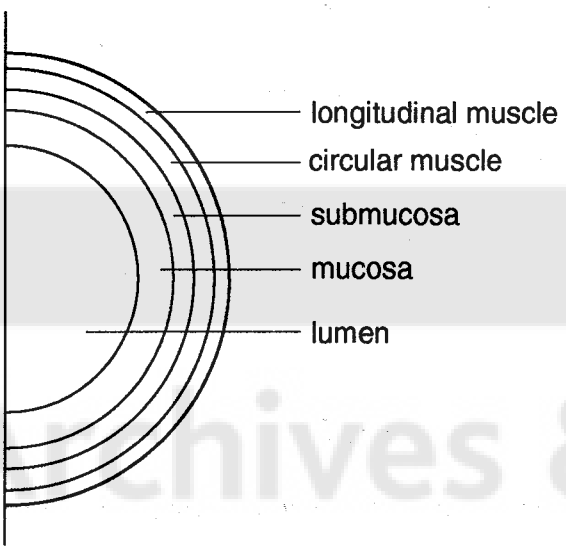

Fig. 3

(a) (i) Make a plan drawing to show accurately the **shape** of the section of the organ and the **distribution** of the tissues in it. *Do* **not** *draw individual cells. It is* **not** *necessary to draw large numbers of the structures projecting into the centre of the section.*

Plan drawing of **K3**

(ii) State the magnification of your plan drawing and the method of calculating it.

Magnification

.....

Method of calculation

.....

(iii) Suggest why the muscles are arranged in circular and longitudinal layers.

.....

.....

(iv) What do you think is the significance of the presence of the large number of structures which project into the lumen of the organ?

.....

.....

Find a region of the section where one of the projections has been cut along its entire length. Use the high power of your microscope to find a region along this projection where you can see clearly the structure of the **two** different types of cells which make up the surface layer of the projection. The **less** abundant cells, which are stained blue, are mucus-secreting cells.

(b) (i) Make a high power drawing to show the detailed structure of **three** adjoining cells which are typical examples of the **more abundant** of the two types of cells.

High power drawing

(ii) State **four** ways in which the structure of the mucus-secreting cells differs from that of the cells you have drawn in **(b)(i).**

.....

.....

.....

(iii) Why is the secretion of mucus important in this organ?

.....

.....

.....

(c) In an investigation, the numbers of mucus-secreting cells which occurred on 20 complete projections were counted in two different regions of the small intestine. Means were calculated and compared.

What test would you use to decide if the difference between mean scores was statistically significant?

.....

.....

[18]

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REPORT FORM

The teacher responsible for this subject is asked to answer the following questions:

(a) Was the candidate physically handicapped in drawing or using a microscope? If so, give brief details.

(b) Was the candidate handicapped by deficient material or apparatus? If so, give brief details.

(c) Was it necessary to make any substitutions for the materials sent from Cambridge? If so, give brief details of the circumstances.

(d) Any comments.

Signed .....

N.B. *Information which applies to all candidates need only be given on the first candidate's answer book.*

UNIVERSITY OF CAMBRIDGE LOCAL EXAMINATIONS SYNDICATE

General Certificate of Education Advanced Level

INSTRUCTIONS FOR 9260/5

PRACTICAL BIOLOGY

JUNE 1994

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

Each candidate must be provided with a microscope with low power and high power objectives (e.g. $\frac{2}{3}$in and $\frac{1}{6}$in) for which sole use is required for seventy minutes.

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

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

F = highly flammable substance

H = harmful or irritating substance

O = oxidising substance

T = toxic substance

In this context, the attention of Supervisors is drawn to the following publications relating to safety and first-aid:

(a) 'Hazcards', as published by CLEAPSS Development Group, Brunel University, Uxbridge, UB8 3PH (0895-51496);

(b) 'Hazard Data Sheets', published by BDH Laboratory Supplies.

These instructions consist of 4 printed pages.

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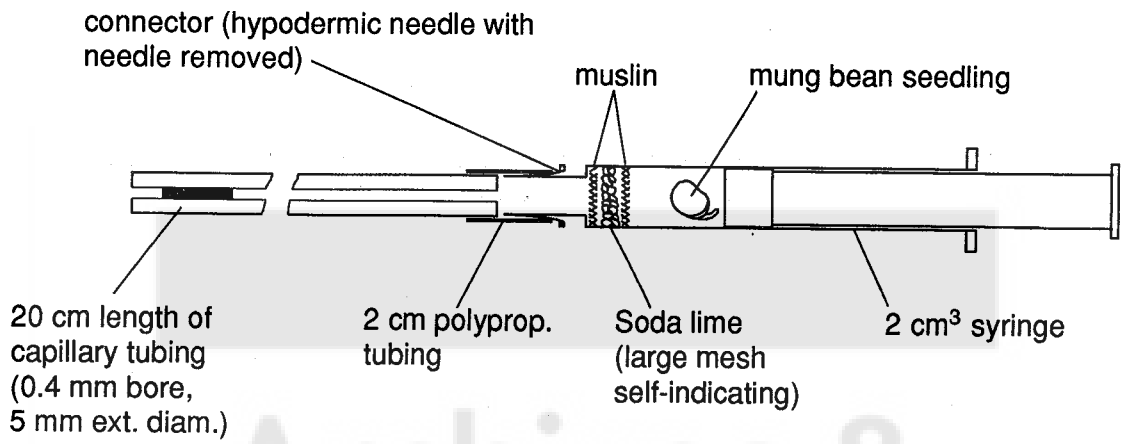
Each candidate must also be provided with the following apparatus and materials:

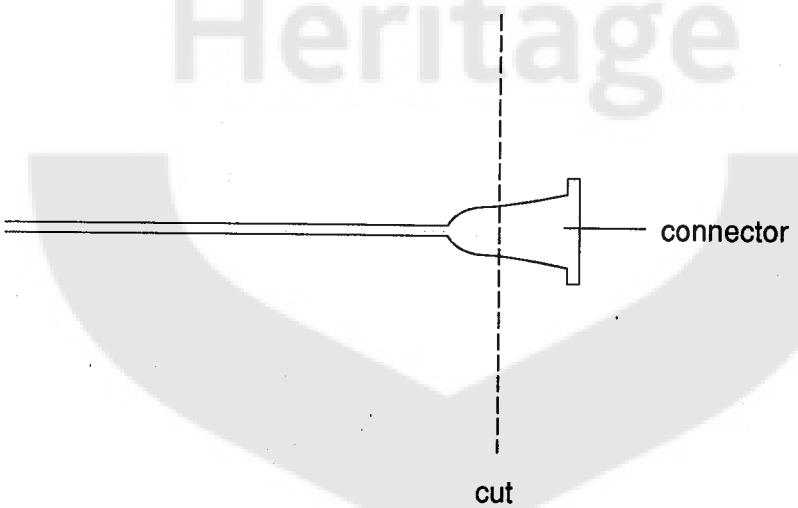
TO BE SUPPLIED BY THE CENTRE

Question 1

Each candidate is required to set up and use the respirometer shown:



The free end of the capillary tube (**0.4 mm bore**) should be flame-polished. The syringe connector is made by cutting the needle from the plastic connector, using a pair of pliers, in the position shown below.



(i) The respirometer should be supplied to candidates **without** the mung bean, with the capillary tube fitted with the syringe connector but **detached** from the syringe and **without** manometer fluid.

Prepare the syringe as follows:

Place a square of muslin (about 2 cm side) loosely at the bottom of the barrel of a new 2 cm^3 syringe. Add 0.1 g of [**C.H.T.**] soda lime granules (fresh stock, coarse mesh, self-indicating type), followed by a further piece of muslin to hold the soda lime in position. Grease the piston of the syringe with a little burette tap grease so that it moves easily when replaced in the barrel.

(ii) Three or four germinated mung beans, with radicles 3 to 5 mm in length, in a Petri dish labelled **mung beans**. Mung beans should be sown **thinly** on moist blotting paper and placed in a warm place about 24 hours before the examination. They should be rinsed and dried before being given to the candidates.

(iii) 2 to 3 cm^3 of manometer fluid in a specimen tube fitted with a lid or cork and labelled **manometer fluid**. This is prepared by shaking a small amount of Sudan III or Sudan blue dye in **[F]** kerosene (domestic paraffin oil). An intensely-coloured liquid can be decanted from any undissolved dye.

(iv) A further 2 cm^3 syringe, greased as before, but empty; a small amount of blotting paper or a circle of filter paper; sheet of graph paper (cm and mm); stopwatch or stopclock (seconds); pair of fine forceps.

Note

1 Syringes containing soda lime may be prepared the day before the examination. They should be stored in a sealed jar or tin. Some extra syringes and capillary tubes should be prepared as spares for any candidates who might require substitute apparatus.

2 The period needed for germination of the mung beans should be checked well in advance of the examination. It can be extended if necessary.

TO BE SUPPLIED BY CAMBRIDGE

(i) Answer books which also contain the questions.

(ii) Slides **K1** and **K2** (Question 2).

(iii) Slide **K3** (Question 3).

SUITABILITY OF APPARATUS AND MATERIAL

In order to check the suitability of apparatus and material, the teacher responsible for preparing the examination is allowed to consult the separate question paper on receipt at the Centre. **This copy of the question paper must be kept under suitable security until the time of the examination.**

The teacher is strongly advised to try out all experiments before the examination.

RETURN OF EXAMINATION MATERIALS TO CAMBRIDGE

Immediately after the examination, the slides K1, K2 and K3 must be returned to Syndicate Buildings in the container in which they were received; they must not be included in parcels of scripts. Pack carefully and attach the pink address label supplied to the outside of the parcel. On occasion, it may be possible for the Syndicate to offer certain slides or materials, used in the examination, for sale to Centres. In this case, an Order Form will be enclosed with the materials sent from Cambridge for the examination. Slides and containers not returned in good condition will be charged at the rate of £2 per item.

POSTAGE OF EXAMINATION SCRIPTS

1 The attention of the teacher responsible for the examination is drawn to the fact that candidates' scripts must be sent directly to the examiner.

2 Candidates' scripts and the attendance register should be placed in a large envelope, a white self-adhesive label bearing the examiner's name and address should be attached and the envelope posted to the examiner.

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