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A Level

Biology

Session: 1984 June
Type: Question paper
Code: 9260

SUMMER 1984

BIOLOGY 9260/1

ADVANCED LEVEL

PAPER 1

(Two and a half hours)

Answer any **four** *questions.*

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

Candidates are advised to study the questions carefully and to answer them concisely.

The figures in square brackets indicate approximate mark values. Up to 2 marks in each question are awarded for quality of expression.

1 (*a*) What is understood by the expression, "*One gene : one polypeptide*"? [4]

(*b*) Describe the mechanism of protein synthesis in the living cell. [14]

2 Describe the important features of gaseous exchange surfaces, with reference to their function in the insect tracheal system, mammalian lungs, and leaf palisade mesophyll. [18]

3 Describe the mechanisms by which water passes through a plant from the soil to the atmosphere, showing how the various cells along its path are adapted for their function. [18]

4 Explain the following terms using an example in each case to make the meaning clear:

(*a*) backcross (test cross), [4]

(*b*) sex linkage, [5]

(*c*) crossing over, [5]

(*d*) multiple alleles. [4]

5 (*a*) Describe the role of hormones in controlling the oestrous cycle of a mammal. [14]

(*b*) Suggest reasons why the endocrine system, rather than the nervous system, is used for this function. [4]

6 (*a*) With reference to suitable **named** examples, discuss adaptations to a parasitic mode of life. [14]

(*b*) Suggest reasons why some groups of organisms possess many parasitic species, while other groups possess few or none. [4]

7 Give an account of the structure, function and distribution of chloroplasts in leaves. [18]

8 (*a*) List those features that distinguish viruses from bacteria. [4]

(*b*) Draw a typical virus and explain how it infects its host and reproduces. [10]

(*c*) Why is it that viruses frequently cause diseases in organisms? [4]

9 (*a*) Define the terms "*habitat*" and "*niche*". [4]

(*b*) With reference to a population of a **named** organism in a **named** habitat, describe the factors that control population size. [10]

(*c*) How may this population vary in size with time? [4]

BIOLOGY 9260/2

ADVANCED LEVEL

PAPER 2

(One and a half hours)

Attempt **all** *the questions.*

Give short answers.

Answers must be written on the lines or in the spaces provided and nowhere else.

Mathematical tables are available from the Supervisor.

The figures shown in squared brackets [ ] *indicate approximate mark allocations.*

1 The dry mass of potato tubers and the shoots that they produced on sprouting was determined at weekly intervals over a period of 8 weeks. The results are given in Table 1 below.

Organ	1	2	3	4	5	6	7	8	*Week*
Tuber	14·1	13·0	10·6	8·2	7·5	6·2	5·3	4·5	*mean dry mass /g*
Shoots (stems)	0	0	0·2	0·5	0·8	2·6	6·0	10·2	
(leaves)	0	0	0·1	0·2	0·7	3·2	6·8	11·0	

Table 1

(*a*) State **two** reasons why the dry mass of the tubers falls.

1. .....

2. .....

(*b*) How would you explain the rapid increase in dry mass of the stems and leaves after week 5?

.....

.....

.....

(*c*) Describe, giving practical details, how such dry mass measurements are made.

.....

.....

[11]

2 Table 2 below shows that animal and plant tissues vary considerably in the relative abundance of the various major classes of constituent chemicals.

	Water	*Protein*	*Lipid*	*Carbohydrate*	*Minerals*
	(Content as percentages)				
Animal	60	20	15	1	4
Plant	60	5	1	30	4

Table 2

Why do animals differ from plants in their protein, lipid and carbohydrate content?

(*a*) *Protein*

.....

.....

.....

(*b*) *Lipid*

.....

.....

.....

(*c*) *Carbohydrate*

.....

.....

.....

[6]

3 Fig. 1 is a diagram of part of a tissue from a plant stem as seen in transverse (**A**) and longitudinal (**B**) section.

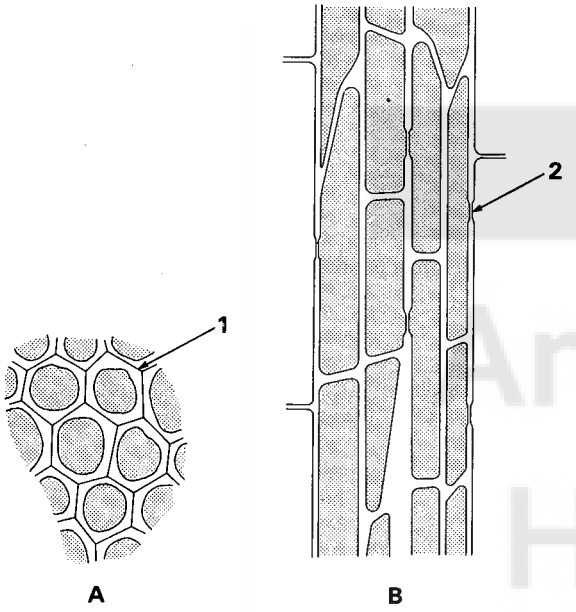


Fig. 1

(*a*) Name the tissue. What features enable you to recognise it as such?

Name .....

Features .....

.....

(*b*) Name the structures labelled 1 and 2.

1. .....

2. .....

(*c*) (i) In what type of stem would you expect to find this tissue?

.....

(ii) Where would it be situated?

.....

(*d*) (i) What is the main function of such a tissue?

.....

(ii) What features of its cell walls are important in adapting it to its particular function?

.....

.....

.....

(*e*) Where else would you expect to find such a tissue?

.....

[10]

4 (*a*) *Fill in the missing words in the text below.*

By definition, a catalyst is effective in ..... amounts, is ..... by the reaction and affects only the ..... of the reaction and not the ..... position of the reaction. In addition enzymes are highly ..... in their action, a result of the fact that they have an ..... which only binds with substrate molecules with a particular molecular ..... Enzymes increase the rate of reactions by effectively reducing the ..... energy of the reaction.

(*b*) Fig. 2 is a graph of the reaction velocity (**V**), as a function of the substrate concentration [**S**] for a fixed amount of enzyme.

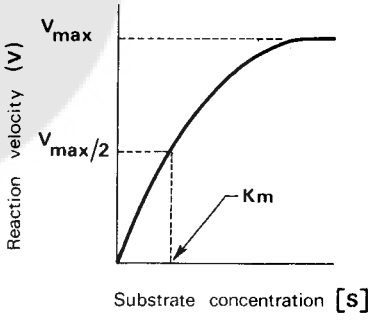


Fig. 2

(i) This illustrates that with a fixed amount of enzyme, **V** is almost ..... proportional to [**S**] when [**S**] is ..... At very high [**S**], **V** is nearly ..... of [**S**].

(ii) How would you account for these relationships?

.....

.....

.....

.....

(iii) K_m is called the Michaelis constant. What is the significance of knowing this value?

.....

.....

[10]

5 The MN blood group system in Man depends upon the inheritance of one pair of alleles. In a sample of 1 100 Chinese from Peking, it was found that the number of people with blood group M was 356, with MN, 519 and with N, 225 respectively.

(*a*) Calculate the frequencies of the two alleles and the expected Hardy-Weinberg genotypic ratios.

Frequency of allele M

Frequency of allele N

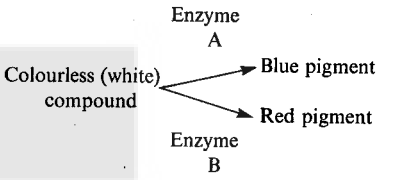
Expected Hardy-Weinberg genotypic ratios

(*b*) Is the population in Hardy-Weinberg equilbrium?

.....

[9]

6 In a certain plant, the flower petals are normally purple. Two recessive mutations have occurred in separate plants and have been found to be on different chromosomes. Mutation 1 (m_1) gives blue petals when homozygous (m_1m_1). Mutation 2 (m_2) gives red petals when homozygous (m_2m_2). Biochemists working on the synthesis of flower pigments in this species have already described the following pathway:



(*a*) Which homozygous mutant must be deficient in enzyme A activity?

.....

(*b*) A plant has a genotype $M_1m_1M_2m_2$

(i) What would its phenotype be?

.....

(ii) If the plant is self-pollinated, show, by means of a full genetic explanation, what colours of progeny are expected, and in what proportions?

.....

.....

(Show your workings on the page opposite.)

(*c*) Why are these mutations recessive?

.....

.....

[8]

(*b*) (ii) *Show your workings here.*

7 Populations of organisms vary greatly in their ability to withstand sustained losses. Populations of the Australian sheep blowfly (*Lucilia cuprina*) were maintained in laboratory cultures on a limited food supply and varying percentages of the newly emerged adults were destroyed. The results are summarised in Table 3 below.

Compensatory reaction of laboratory populations of the Australian sheep blowfly (*Lucilia cuprina*) to the destruction of adult flies.

Emerging adults destroyed %	*Adults emerging per day*	*Mean adult population*	*Mean adult lifespan days*	*Mean no. viable eggs laid per adult per day*
0	573	2520	4·4	0·25
50	712	2335	6·6	0·33
75	878	1588	7·2	0·60
90	1260	878	7·0	1·55

Table 3

How, and to what extent, did the population compensate for such losses?

.....

.....

.....

..... [6]

BIOLOGY **9260/3**

ADVANCED LEVEL

PAPER 3

(*One hour*)

DO NOT OPEN THIS BOOKLET UNTIL YOU ARE TOLD TO DO SO

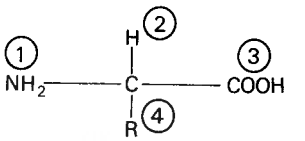
Read these notes carefully

There are forty questions in this test. For each question five suggested answers are given: you are to choose the most appropriate one and indicate it on the separate answer sheet.

Read the instructions on the separate answer sheet very carefully.

Attempt **all** *the questions. Marks will not be deducted for wrong answers: your total score on this test will be the number of correct answers given.*

1 An amino acid molecule has the following structure:



Which **two** of the groups combine to form a peptide link?

A 1 and 2
B 1 and 3
C 2 and 3
D 2 and 4
E 3 and 4

2 Consider the following statements about the properties of water. It has

1 a high specific heat.
2 a high latent heat of vapourisation.
3 a high tensile strength.
4 a high surface tension.
5 a low viscosity.
6 a high electrical conductance.

Which combination of these properties is important in the movement of water through a plant and in the cooling effect of transpiration?

A 1 2 3 6
B 1 3 5 6
C 1 4 5 6
D 2 3 4 5
E 2 3 4 6

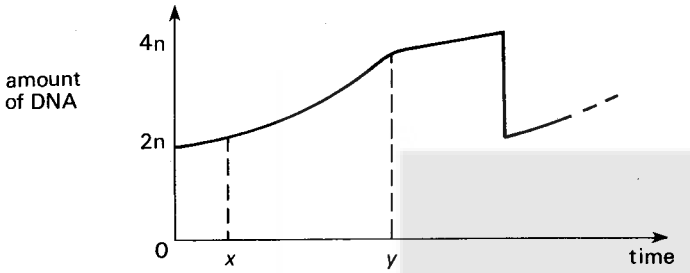
3 Vitamins of the B group (complex) act as

A respiratory inhibitors.
B metal ion activators.
C parts of ATP molecules.
D osmotic inhibitors.
E co-enzymes.

4 Which one of the following organelles always contains DNA?

A centriole
B Golgi apparatus
C lysosome
D mitochondrion
E ribosome

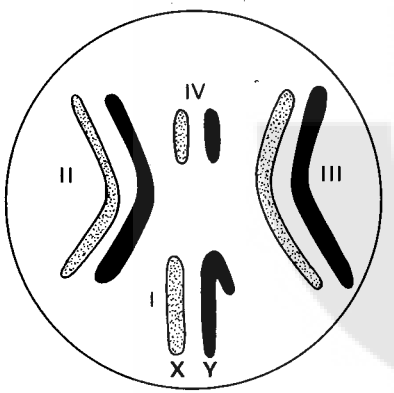
5 The graph below shows the changes in DNA content in a single cell during the mitotic cycle.



Which stage occurs between time *x* and time *y*?

A interphase
B prophase
C metaphase
D anaphase
E telophase

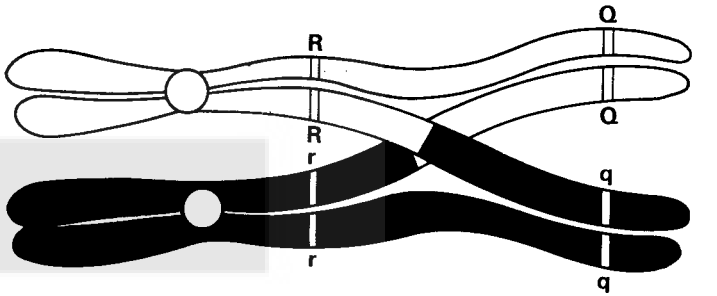
6 The diagram below shows a sperm mother cell of *Drosophila*, with the maternal and paternal chromosomes shaded differently.



What is the probability of a sperm receiving all **four** maternal chromosomes?

A 0
B 1 in 2
C 1 in 4
D 1 in 8
E 1 in 16

7 The diagram below represents a pair of homologous chromosomes during prophase of meiosis.



During which anaphase(s) of the two meiotic divisions do alleles **R** and **r** and alleles **Q** and **q** subsequently separate?

	alleles **R** *and* **r**	*alleles* **Q** *and* **q**
A	at anaphase I	at anaphase I
B	at anaphase I	at anaphase II
C	at anaphase II	at anaphase I
D	at anaphase II	at anaphase II
E	at anaphase I and again at anaphase II	at anaphase I and again at anaphase II

8 If 30% of the bases in a DNA molecule are adenine, what percentage of the bases are guanine?

A 15%
B 20%
C 30%
D 40%
E 70%

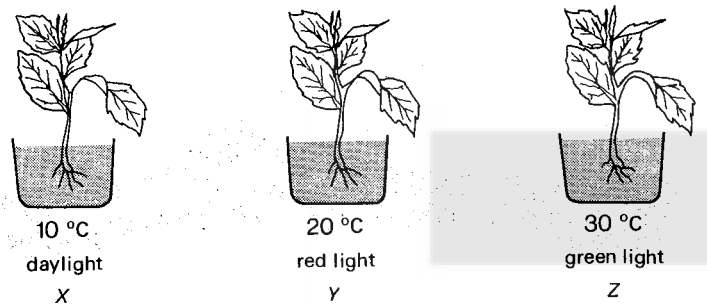
9 Messenger RNA is synthesised in the

A cytoplasm and then is transferred to the nuclear DNA.
B cytoplasm and then is transferred to the ribosomes.
C nucleus from nucleotides assembled on the nuclear DNA.
D nucleolus and then is transferred to the ribosomes.
E ribosomes on the endoplasmic reticulum.

10 Which one of the following pairs of tissues has cell walls thickened with lignin?

A collenchyma and cork
B collenchyma and sclerenchyma
C collenchyma and sieve tubes
D sclerenchyma and xylem vessels
E sieve tubes and cork

11 The diagram below shows three plants with identical leaf surface areas.



Assuming all other conditions were identical for all three plants, which of the plants would be likely to photosynthesise slowest, and which fastest?

A *X* slowest, *Y* fastest
B *Y* slowest, *Z* fastest
C *Z* slowest, *X* fastest
D *X* slowest, *Z* fastest
E *Z* slowest, *Y* fastest

12 Removal of the source of carbon dioxide from photosynthesising chloroplasts results in rapid changes in the concentration of certain chemicals. Which one of the following represents the correct combination of concentration changes?

	ATP	*ribulose diphosphate (bisphosphate)*	*phosphoglyceric acid (PGA)*
A	decreases	decreases	increases
B	decreases	increases	no change
C	increases	increases	decreases
D	increases	no change	increases
E	no change	decreases	decreases

13 When 1 cm^3 of human bile was added to 5 cm^3 of milk in a test tube which also contained a few drops of universal indicator solution, the colour change indicated an increase in pH. Which one of the following functions and properties of bile accounts for the change in pH?

A Bile hydrolyses lipids and releases fatty acids.
B Bile emulsifies fats giving them a larger surface area for digestion to occur.
C Bile has a high optimum pH.
D Bile contains alkaline salts.
E Bile contains bile pigments.

14 Pepsin, trypsin, and chymotrypsin are proteolytic enzymes that

A are all secreted with acid digestive juices.
B are all secreted by the pancreas, but activated by the secretions of the duodenum.
C break down proteins to amino acids.
D are exopeptidases, being either carboxy- or amino-peptidases.
E are specific endopeptidases releasing peptide and polypeptide chains.

15 The table below shows the volume of oxygen taken up by a gerbil and the volume of carbon dioxide produced per minute at 25°C.

oxygen uptake/cm^3	*carbon dioxide produced/cm^3*
12·3	10·1
12·8	10·5
12·5	10·2
13·4	10·7
12·5	10·6

Given that the formula for calculating the standard deviation (S.D.) is

$$S.D. = \sqrt{\frac{\Sigma(x - \bar{x})^2}{n}}$$

where x = *sample value*
$\bar{x}$ = *mean*
n = *number in sample*
Σ = *sum of . . .*

Which one of the following values represents the mean respiratory quotient and the standard deviation of the mean?

	mean	*standard deviation*
A	0·82	0·018
B	0·82	0·65
C	1·22	0·018
D	1·22	0·65
E	23·12	0·65

16 A small aquatic plant was put in each of three petri dishes, **X**, **Y**, **Z**, containing different culture solutions. After six weeks the plant in dish **X** had the same number of leaves as it had previously and they were all small and yellowish. The plant in dish **Y** had more leaves and they were of normal size and much darker green. The plant in dish **Z** also had more leaves, of normal size but very pale. Which one of the following shows which elements were missing from the culture solutions?

	X	**Y**	**Z**
A	magnesium	nitrogen	phosphorus
B	magnesium	phosphorus	nitrogen
C	nitrogen	phosphorus	magnesium
D	phosphorus	magnesium	nitrogen
E	phosphorus	nitrogen	magnesium

17 The osmotic concentration of mammalian urine is controlled by anti-diuretic hormone (ADH). In which part of the nephron does this occur?

A the glomerulus
B the proximal convoluted tubule
C the descending limb of the loop of Henle
D the ascending limb of the loop of Henle
E the collecting duct

18 Which part of the mammalian brain is directly associated with the learning process?

A cerebellum
B cerebrum
C corpora quadrigemina
D medulla
E pons

19 A sample of blood added to a hypotonic saline solution in a test tube resulted in a uniform red colouration in the solution which was unaffected by centrifugation. Which one of the following explains this result?

A The haemoglobin has diffused through the erythrocyte membrane into the saline solution.
B Water has entered the erythrocytes by osmosis. As they are now less dense than the hypotonic solution, they will not sediment.
C Water has left the erythrocytes by osmosis, causing the cells to shrink, and to become too small to sediment.
D Water has entered the erythrocytes by osmosis, causing them to swell and burst and the haemoglobin is now in the solution.
E Water has entered the intact erythrocytes in exchange for the haemoglobin.

20 Which one of the following correctly describes a feature of transport in phloem tissue?

A Movement in the phloem is a passive process.
B Movement in the phloem is linked to respiratory processes.
C Movement in the phloem only occurs towards the roots.
D No salts are translocated in the phloem.
E Phloem is the only tissue to transport organic compounds.

21 Which one of the following structures of the mammalian ovary produces progesterone?

A corpus luteum
B germinal epithelium
C Graafian follicle
D mature oocyte
E primary ovarian follicles

22 If the genotype of the ovule-bearing flower is **AA** and that of the pollen-bearing flower is **aa**, the genotype of the endosperm in the seed will be

A **AA.**
B **Aa.**
C **A.**
D **Aaa.**
E **AAa.**

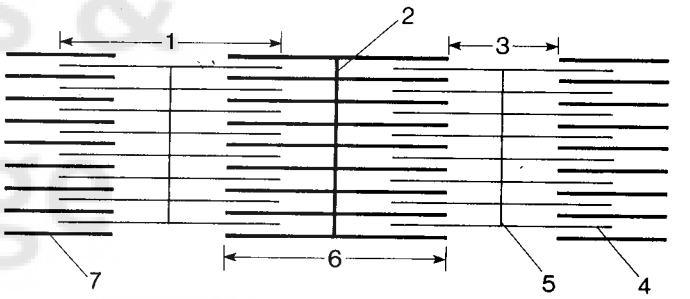
23 The dorsal fin of a bony fish prevents

A rolling, yawing and pitching.
B rolling and yawing but not pitching.
C rolling but neither yawing nor pitching.
D pitching and rolling but not yawing.
E yawing and pitching but not rolling.

24 Which one of the following has **least** influence on cell elongation in a meristem?

A enzyme activity in the synthesis of new cellulose
B the availability of water to the tissue
C the water potential (diffusion pressure deficit) of the cell sap
D the synthesis of new DNA in the nucleus
E the presence of indoleacetic acid in the cell wall

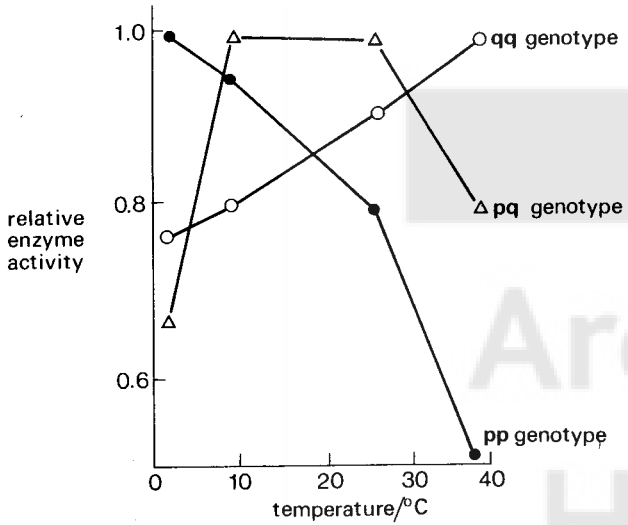
25 The diagram below shows the ultrastructure of part of a skeletal muscle fibre.



Which numbers indicate the " **A** " band, the " **Z** " line and the **actin** filaments?

	" A " band	*" Z " line*	*actin filaments*
A	1	2	7
B	3	2	4
C	1	5	7
D	6	5	4
E	3	2	7

26 In the North American catfish *Catostomus clarki*, two alleles, represented by **p** and **q**, control the synthesis of a vital enzyme. The three possible genotypes (**pp**, **pq**, **qq**) lead to the synthesis of variations of the same enzyme with different temperature optima as shown in the graph below.



When the mean annual temperature is 5°C, which one of the following is correct?

A Allele **p** will be positively selected for.
B Allele **q** will be positively selected for.
C Allele **p** will become dominant and **q** recessive.
D The heterozygotes will have a selective advantage over the homozygotes.
E No genotype will have a selective advantage over another.

27 Red-green colour blindness in mammals is a sex-linked recessive trait. If a colour-blind female is crossed with a normal male then the theoretical ratio of the offspring will be

A 50% carrier females, 50% colour-blind males.
B 50% normal females, 50% colour-blind males.
C 50% carrier females, 50% normal males.
D 25% carrier females, 25% normal females, 50% normal males.
E 50% carrier females, 25% normal males, 25% colour-blind males.

28 The Hardy-Weinberg law assumes

A a large population, no mutation and random reproduction.
B a large population, mutation and non-random reproduction.
C a small population, mutation and random reproduction.
D a small population, no mutation and non-random reproduction.
E a small population, mutation and non-random reproduction.

29 Genes located on the same chromosome are said to be

A allelic.
B autosomal.
C complementary.
D linked.
E non-allelic.

30 A disease caused by a recessive gene has an incidence of one per cent of the population. What percentage of the whole population would be expected to be carriers of the gene but unaffected by the disease?

A 9%
B 18%
C 19%
D 81%
E 99%

31 A mutation is a change produced by an alteration in the genetic mechanism and

A may arise spontaneously.
B is always induced by the environment.
C is never advantageous.
D is not inherited.
E only leads to continuous variation.

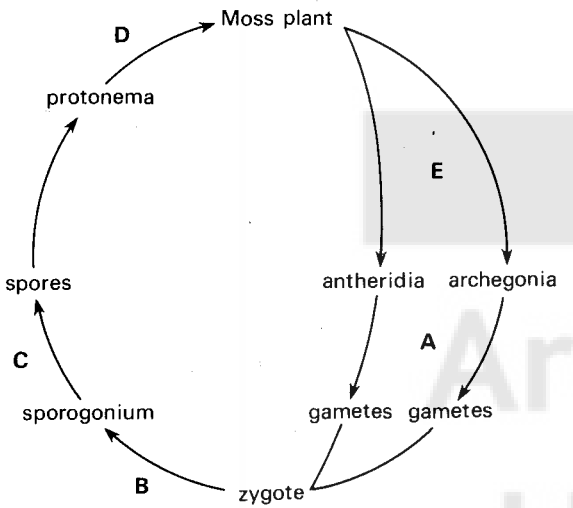
32 In haemoglobin, the amino acid sequence of the beta (β) polypeptide chains differs among the species which possess the molecule. The beta chains of the species shown in the table below were analysed. The number of amino acid differences between Man and each of the species was counted and ranged between 8 and 127. Which one of the following shows the differences which would be consistent with the proposed evolutionary relationships between the organisms?

	amino acid differences				
	dog	*earthworm*	*frog*	*lamprey*	*rhesus monkey*
A	8	67	15	127	125
B	15	127	67	125	8
C	67	15	127	8	67
D	125	8	67	15	127
E	127	125	8	67	15

33 Which one of the following sets of features could be used to construct a dichotomous key in order to distinguish between an insect, a crustacean and a small mammal?

A endoskeleton and antennules
B endoskeleton and exoskeleton
C eyes and bilateral symmetry
D eyes and jointed appendages
E jointed appendages and exoskeleton

34 The diagram below summarises the life-cycle of a typical moss. Select the letter that shows the stage at which meiosis takes place.



35 Which one of the terms below correctly describes the relationships between the flight organs of the following animals: locust, bat, swallow and flying fish?

A analogous
B homologous
C homozygous
D monotypic
E zygomorphic

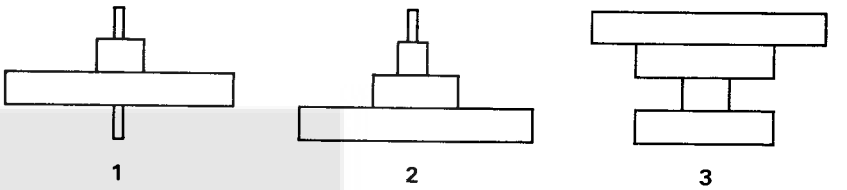
36 Mesoderm tissue is absent in the

A Annelida.
B Coelenterata.
C Crustacea.
D Insecta.
E Nematoda.

37 The expression " ecological niche " is defined as

A where an organism lives.
B a group of individuals living together.
C the role an organism plays in an ecosystem.
D all the populations of a specific area.
E what an organism feeds on in an ecosystem.

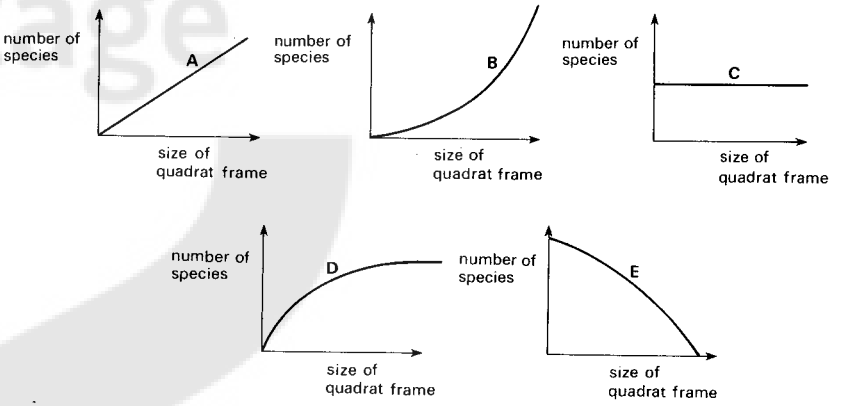
38 An isolated oak tree supports a large population of insects, which are the food of small birds. These birds are the prey of kestrels and owls. These relationships may be represented by diagrams.



Which one of the following correctly describes the diagrams above?

A **1** represents a pyramid of standing crop biomass and **2** represents a pyramid of numbers.
B **1** represents a pyramid of numbers and **2** represents a pyramid of energy.
C **1** represents a pyramid of energy and **2** represents a pyramid of standing crop biomass.
D **2** represents a pyramid of numbers and **3** represents a pyramid of energy.
E **2** represents a pyramid of standing crop biomass and **3** represents a pyramid of numbers.

39 In order to estimate the relative abundance of different species in an ecosystem, use is often made of a quadrat frame thrown at random. Which one of the graphs below, **A**, **B**, **C**, **D** or **E**, correctly represents the relationship between the size of quadrat frame used and the number of species recorded?



40 A trout farmer nets 150 trout, tags them and returns them to a pond of surface area 5 000 m^2. Two days later he repeats his netting procedure and captures 420 fish, 14 bearing the tags put on two days previously. Assuming that there is no mortality between tagging and recapturing, what is the population of fish expressed as numbers of individuals per 100 m^2?

A 42
B 90
C 210
D 450
E 4 500

BIOLOGY 9260/4

ADVANCED LEVEL

PRACTICAL TEST

ALTERNATIVE A

(Three hours)

Answer **all** *questions.*

Answers must be written in ink in the places indicated.

Additional pages must not be inserted.

The times recommended for the questions are for guidance only.

Figures in square brackets [ ] *show approximate mark allocations.*

Candidates may be penalised for recording irrelevant information.

You are strongly advised to spend the first fifteen minutes carefully reading through the whole paper before starting to answer any questions.

Question 1 (65 *minutes*)

You are provided with the following labelled solutions:

Sugar A (very common in plants) ..... 0·2 M solution,

Sugar B (produced only in mammals) ..... 0·2 M solution,

Sugar C (very common in animals) ..... 0·2 M **and** 0·4 M solutions.

Determine the effect of suspension **K1** on the four solutions and identify the sugars as far as possible.

Proceed as follows:

Label four test-tubes **A**, **B**, **C1** and **C2** respectively. Shake or stir suspension **K1** to mix it completely and put 10 cm^3 into each of the four tubes. Then add to

tube **A** ..... 10 cm^3 **sugar A solution**;

tube **B** ..... 10 cm^3 **sugar B solution**;

tube **C1** ..... 10 cm^3 **sugar C** (0·2 M) **solution**;

tube **C2** ..... 10 cm^3 **sugar C** (0·4 M) **solution.**

Shake the tubes and place them in a container of water at 38–42 °C. To each of the tubes fit the apparatus as shown in Fig. 1. (Only two of the tubes are shown). Make sure that the fitting is air tight. The tubes containing the limewater can stand in a test-tube rack in front of the water container.

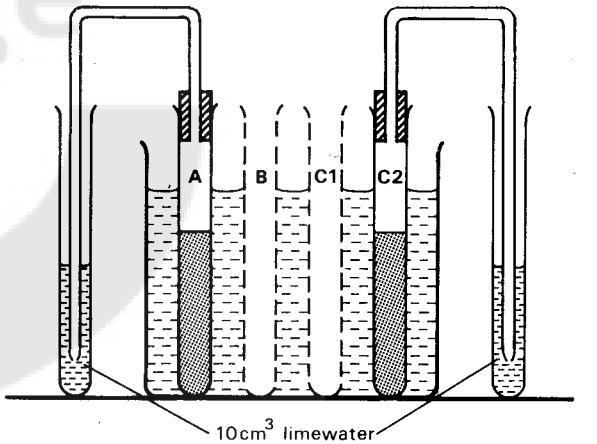


Fig. 1

Now record the time here .....

Leave this experiment until bubbles of gas are given off regularly. (About 25–30 minutes). During this time continue with Question **2**, but maintain the temperature of the water at 38–42 °C by adding more hot water when necessary.

(*a*) (i) When the bubbling is regular, count the number of bubbles given off in 1 minute from tube **A**. Do this by putting a small stroke (/) in the appropriate space in the table below, each time you observe a bubble. An example is shown. Now count the number of bubbles given off by tube **C1** and then by tube **C2** in one minute and record your results in the same way. Repeat this procedure to obtain **three** counts for **each** of the tubes **A**, **C1** and **C2**. You may be able to count the bubbles from two or three tubes simultaneously. Observe tube **B** for **one** minute.

Table of readings

	Number of bubbles per minute		
	Tube **A**	*Tube* **C1**	*Tube* **C2**
Example	//// = 5	—	—
First count			
Second count			
Third count			
Average number			

Record the average number of bubbles per minute for tubes **A**, **C1** and **C2**.

(ii) How many bubbles have you observed being given off by tube **B**? .....

(*b*) Using only the reagents provided, the labelled solutions and the information given above and gained by counting the bubbles identify, as far as possible, sugars **A**, **B** and **C**. Briefly record your methods, observations and conclusions.

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(*c*) **After** you have counted the bubbles, carry out Benedict's or Fehling's test on the liquid in tube **A**. Record your observations and conclusion. (Suspension **K1** has no effect on these reagents.)

.....

(*d*) Name the type of chemical reaction which has taken place in tube **A** to give the result you have observed in (*c*).

.....

(*e*) Place a very small drop of **K1** on a slide. Add **four** drops of water and cover with a coverslip. Observe this carefully, under your microscope. Briefly describe your observations.

.....

.....

(*f*) Using these observations, and the information gained previously, identify **K1**.

.....

(*g*) Briefly describe a simple procedure you could follow to determine whether **K1** was living or dead.

.....

.....

(*h*) Name the biological process taking place in tubes **A**, **C1** and **C2**.

.....

(*i*) Using all the information you have gained, explain as fully as possible the **similarities** and **differences** between the rates of reaction in tubes **A**, **C1** and **C2**.

.....

.....

.....

.....

(*j*) What was the limiting factor in tube **C1**?

.....

(*k*) Explain or account for your observation on tube **B**.

.....

[24]

Question 2 (65 *minutes*)

Investigate some of the anatomical and histological features of the insect provided, as instructed.

Proceed as follows:

(*a*) Cut off the head and pin it to the mat or board with its ventral (posterior) surface uppermost, as shown in Fig. 2 and leave aside until later (*f*).

(*b*) Cut the wings off the body of the insect and discard them. Hold the body of the insect in one hand and, using a pair of sharp scissors, cut through only the exoskeleton in the mid-dorsal line along the whole length of the abdomen and thorax. Place the insect in the dissection dish and, using pins, gently pull the cut edges apart. Pin the insect to the dish so as to expose the internal organs. Cover the insect with saline solution. With a blunt seeker, gently move the structures to reveal parts of the tracheal system (narrow, glistening structures). With forceps and scissors remove a piece of trachea, about 1·5 cm long and place it in a few drops of saline on a labelled slide. Cover the slide with a Petri dish lid to prevent it from drying and leave aside.

Gently free the alimentary canal along its whole length and identify the mesenteric (hepatic or digestive) caeca, immediately behind the gizzard, and the Malpighian tubules originating between the mid and hind gut. With scissors and forceps remove **two** or **three** complete mesenteric caeca and place them in a few drops of saline on a labelled slide. Similarly place a few complete Malpighian tubules in saline on a labelled slide. Cover each slide with a dish.

(*c*) Free the alimentary canal from **all** surrounding tissue and remove it in its entirety. Place it on the filter paper in the plastic Petri dish provided and arrange it in a manner to display the various regions as clearly as possible.

Replace the lid of the Petri dish and set it safely aside until the end of the examination.

(*d*) Carefully observe each of the structures on your **three** slides with a hand lens and under the microscope (low power objective only). For **each** structure, briefly state the **observable** features which distinguish it from the other two.

Trachea

.....

.....

Mesenteric caecum

.....

.....

Malpighian tubule

.....

.....

(*e*) Using filter paper, remove the saline from each slide and cover each structure with five to seven drops of the stain, borax carmine. Cover the slides to prevent them drying and leave them for ten minutes.

(*f*) During this ten minutes, using forceps and the tip of a sharp scalpel, remove, in their entirety, (i) the labium (lower lip) and (ii) the right maxilla from the head. Place these two structures on the diagram, Fig. 2 below in their correct positions and with their ventral (posterior) surfaces uppermost. Fix the structures to the paper with a piece of transparent adhesive tape.

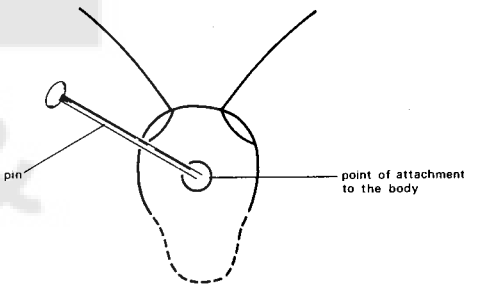

Fig. 2. *Outline of insect's head, ventral (posterior) view.*

(*g*) Using filter paper remove all the excess stain from the three slides. Cover each structure with acid ethanol and leave for two minutes. With filter paper remove the acid ethanol and replace it with 70% ethanol.

(*h*) Leave for two minutes and then replace the ethanol with dilute glycerol solution. Cover each of the structures with a coverslip. Observe a Malpighian tubule and the piece of trachea under the high power of your microscope.

(*i*) Make a **large**, labelled drawing of a **very small** but **typical** portion of:

1. a Malpighian tubule and
2. the piece of trachea.

Malpighian tubule *Piece of trachea*

(*j*) Explain briefly why different parts of the three structures stain differently with the same stain.

.....

.....

(*k*) Explain briefly why saline and not water was used to cover the insect and the three structures.

.....

.....

[22]

Cover each slide with a Petri dish and set aside until the end of the examination.

Question 3 (35 *minutes*)

K2 is a transverse section of a stem of a terrestrial plant. Fig. 3 below is an outline drawing of a typical half of a section very similar to **K2**. Only some of the vascular bundles are shown. Observe **K2** with your microscope.

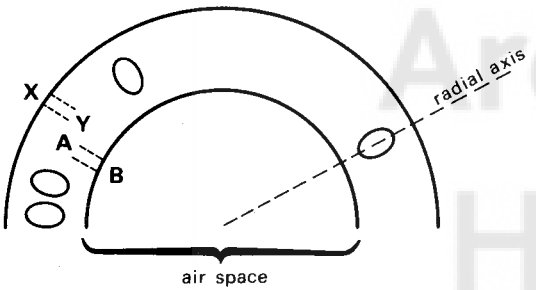

Fig. 3

(*a*) Make a large, labelled plan drawing (about 10 cm long, along radial axis) to show accurately the position and relative amounts of the different tissues in a typical large vascular bundle. (Do **not** draw any cells).

(*b*) On the drawing in (*a*), indicate clearly the position of the youngest (most recently formed) xylem vessels.

(*c*) Observe **K2** using the high power objective. Make a large, labelled drawing of **four** typical adjacent cells in each of **three** different tissues in a strip of cells such as **XY** on Fig. 3.

Tissue 1 *Tissue* 2

Tissue 3

(*d*) State **three** significant differences you can observe between the cells you have drawn in (*c*) and the cells you can observe in a strip such as **AB** on Fig. 3.

.....

.....

(*e*) How do you account for these differences in view of the fact that both strips are close to or in contact with air?

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[14]

Instructions for end of examination

When the examination has ended you will be told to pack your material from Question **2** as follows: .

Cover your dissection with a second filter paper which is then moistened with about 10 drops of 1% formalin. Cover this with a layer of cotton wool. With a pencil, write your name, candidate number and centre number clearly on a piece of paper and place it on top of the cotton wool with the writing uppermost. Replace the lid of the Petri dish and seal it with one long strip of Sellotape.

Write your name, centre number and candidate number on **each** of **three** slide labels. Stick one of these labels to each of your **three** slides. Now stick a 10 cm length of transparent adhesive tape on each slide covering the coverslip and the labels and with the ends folded over and stuck to the undersurface.