

GCE

Specimen Papers with Mark Schemes

**Edexcel Advanced Subsidiary GCE in Biology
(8040) and Biology (Human) (8042)**

First examination 2001

**Edexcel Advanced GCE in Biology (9040) and
Biology (Human) (9042)**

First examination 2002

January 2000

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Question Papers

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Mark Schemes

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The GCE awarding bodies have prepared new specifications to incorporate the range of features required by the new GCE and subject criteria. The specimen assessment material accompanying the new specifications is provided to give centres a reasonable idea of the general shape and character of the new planned question papers in advance of the first operational examination.

Unit Codes and Unit Titles

The following table shows the unit codes and the titles of the units that make up the qualifications in Biology and Biology (Human).

| Level | Unit | Biology | Biology (Human) |
|-------|------|---------|--|
| AS | 1 | 6101 | Molecules and cells 6101 |
| | 2 | 6102 | Exchange, transport and reproduction Exchange, transport and reproduction in humans 6112 |
| | 3 | 6103 | Energy and the environment 6103 |
| A2 | 4 | 6104 | Respiration and coordination and Options 6104 |
| | 5 | 6105 | Genetics, evolution and biodiversity Genetics, human evolution and biodiversity 6115 |
| | 6 | 6106 | Synoptic and practical assessment 6106 |

Cashing in

The following tables show the units that must be taken in order to obtain an award for AS or Advanced GCE Biology, or for AS or Advanced GCE Biology (Human).

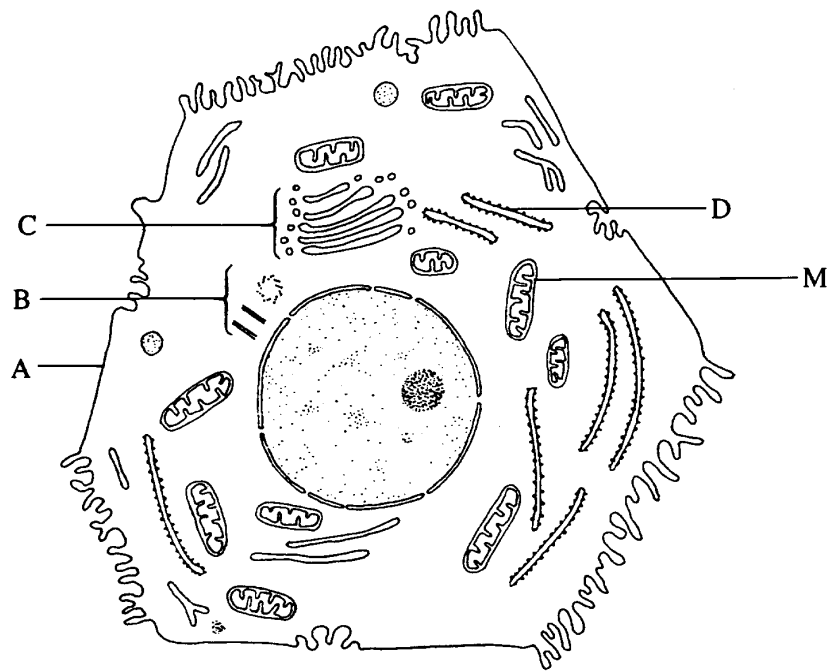
Advanced Subsidiary

| Level | Unit | 8040 Biology | 8042 Biology (Human) |
|-------|------|--------------|----------------------|
| AS | 1 | 6101 | 6101 |
| | 2 | 6102 | 6112 |
| | 3 | 6103 | 6103 |

Advanced GCE

| Level | Unit | 9040 Biology | 9042 Biology (Human) |
|-------|------|--------------|----------------------|
| AS | 1 | 6101 | 6101 |
| | 2 | 6102 | 6112 |
| | 3 | 6103 | 6103 |
| A2 | 4 | 6104 | 6104 |
| | 5 | 6105 | 6115 |
| | 6 | 6106 | 6106 |

1. The diagram below shows the structure of a liver cell as seen using an electron microscope.



(a) Name the parts labelled A, B, C and D.

- A
- B
- C
- D

(4)

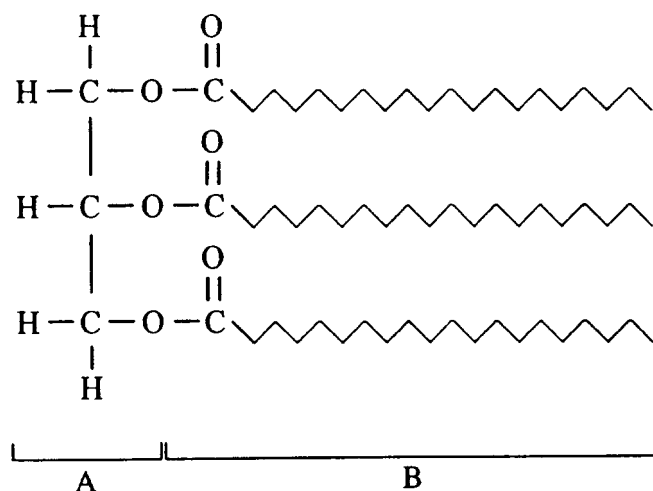
(b) The magnification of the diagram is $\times 12\ 000$. Calculate the actual length of the mitochondrion labelled M, giving your answer in μm . Show your working.

Length

(2)

(Total 6 marks)

2. The diagram below shows the structure of a lipid molecule.



(a) Name the parts labelled A and B.

A

B

(2)

(b) Name this type of lipid

.....

(1)

(c) Name the chemical reaction used to form the bonds between A and B.

.....

(1)

(d) State ONE function of this type of lipid in living organisms.

.....

(1)

(e) State ONE feature of the molecules of this type of lipid that makes them suitable for the function you have given.

.....

(1)

(Total 6 marks)

3. The statements in the table below refer to three polysaccharide molecules.

If the statement is correct place a tick (✓) in the appropriate box and if the statement is incorrect place a cross (✗) in the appropriate box.

| Statement | Starch | Glycogen | Cellulose |
|------------------------------|--------|----------|-----------|
| Polymer of α -glucose | | | |
| Glycosidic bonds present | | | |
| Unbranched chains only | | | |
| Energy store in animal cells | | | |

(Total 4 marks)

4. Explain what is meant by the following terms.

(a) Osmosis

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(3)

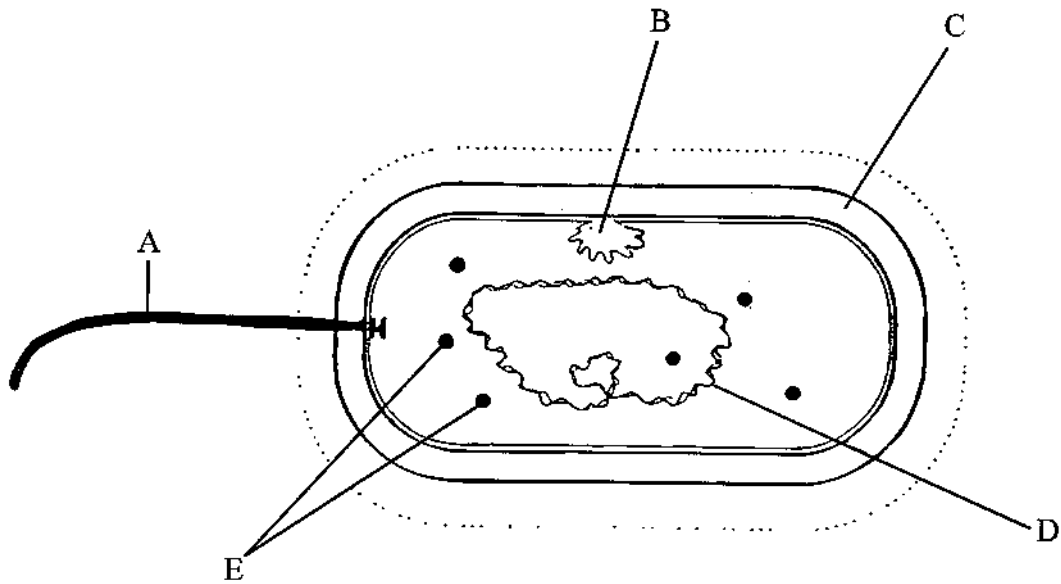
(b) Facilitated diffusion

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(3)

(Total 6 marks)

5. The diagram below shows the structure of a bacterial cell as seen using an electron microscope.



- (a) Name the parts labelled A, C and D.

A

C

D

(3)

- (b) Describe the roles of the parts labelled B, C and E.

B

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C

.....

E

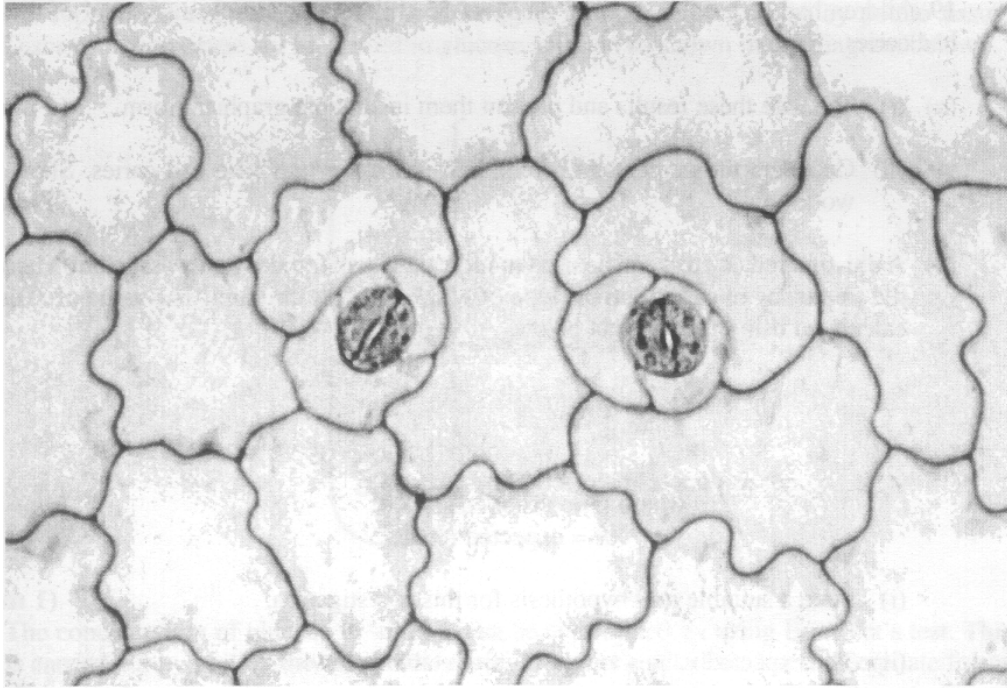
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(3)

(Total 6 marks)

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6. The photomicrograph below shows some cells.



(a) Name the tissue shown in the photomicrograph and describe its function.

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(3)

- (b) In the space below make an accurate drawing, enlarged $\times 1.5$, of the stomata and surrounding cells. Do not label your drawing.

(5)

(Total 8 marks)

7. An experiment was carried out to determine what happens to amino acids after they are absorbed by animal cells. The cells were incubated for 5 minutes in a medium containing radioactively labelled amino acids. The radioactive amino acids were then washed off and the cells were incubated in a medium containing only non-radioactive amino acids.

Samples of the cells were taken at 5, 10 and 45 minutes after the start of the experiment and the sites of radioactivity in the cells were determined.

The results are given in the table below. The figures show radioactivity in certain cell organelles expressed as a percentage of the total radioactivity within the cells.

| Organelle | Percentage of total radioactivity | | |
|-----------------------------|-----------------------------------|---------------|---------------|
| | At 5 minutes | At 10 minutes | At 45 minutes |
| Rough endoplasmic reticulum | 80 | 10 | 5 |
| Golgi apparatus | 10 | 80 | 30 |
| Secretory vesicles | 0 | 5 | 60 |

- (a) Name ONE type of molecule synthesised from amino acids in cells.

.....
(1)

- (b) Explain why the radioactivity is associated mainly with the rough endoplasmic reticulum after the first 5 minutes of the experiment.

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(2)

- (c) Explain the changes in the pattern of radioactivity in the cell during the remaining 40 minutes of the experiment.

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(3)

- (d) Suggest why the figures in the tables total less than 100%.

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(2)

- (e) If the experiment is continued for a further period of time, most of the radioactivity will be found outside the cell.

Name and describe the process which brings about this result.

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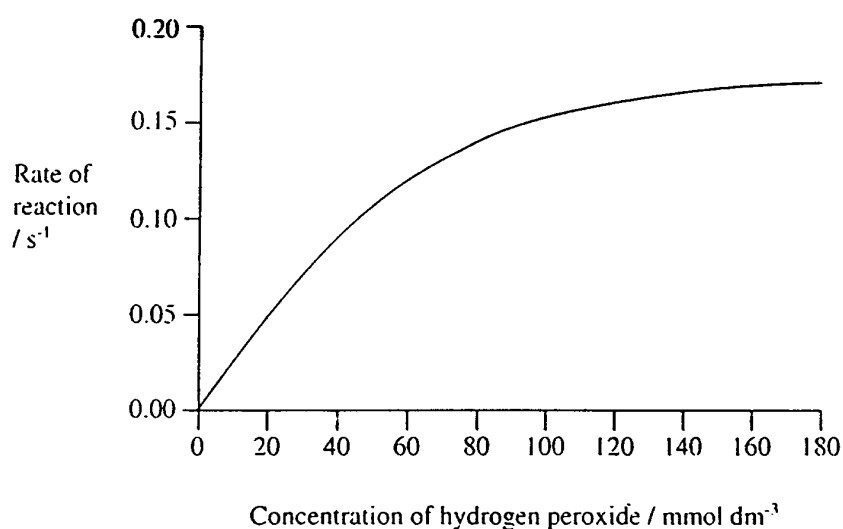
(3)

(Total 11marks)

8. Catalase is an enzyme that breaks down hydrogen peroxide into oxygen and water. The activity of catalase can be measured by soaking small discs of filter paper in a solution containing the enzyme. The discs are immediately submerged in a dilute solution of hydrogen peroxide. The filter paper discs sink at first, but float to the surface as oxygen bubbles are produced. The reciprocal of the time taken for the discs to rise to the surface indicates the rate of reaction.

An experiment was carried out to investigate the effect of substrate concentration on the activity of catalase. A filter paper disc was soaked in a solution containing catalase, and then submerged in a buffer solution containing hydrogen peroxide. The time taken for the disc to rise to the surface was recorded. This experiment was repeated using a range of concentrations of hydrogen peroxide.

The results are shown in the graph below.



- (a) State why a buffer solution was used in this experiment.

.....

 (1)

- (b) Describe the relationship between the rate of reaction and the concentration of hydrogen peroxide as shown by the graph.

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 (3)

(c) Explain this relationship between substrate concentration and the rate of reaction.

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(3)

(d) Describe how a solution containing 160 mmol of hydrogen peroxide per dm³ would be diluted to prepare a solution containing 80 mmol of hydrogen peroxide per dm³.

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(2)

(e) Describe how this experiment could be modified to investigate the effect of temperature on the activity of catalase.

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(4)

(Total 13 marks)

9. Give an account of the process of mitosis.

(Total 10 marks)

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Three lined pages

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| Centre Number | | | | | Paper Reference | Surname |
| Candidate Number | | | | | Candidate Signature | Other Names |

6102/01, 6112/01

Edexcel GCE

Biology Biology (Human)

Unit Test 2B and 2H

Advanced Subsidiary / Advanced Specimen Paper

Time: 1 hour 20 minutes

Materials required for the examination

Nil

Items included with these question papers

Nil

Instructions to Candidates

In the boxes above, write your Centre Number, Candidate Number, the Paper Reference, your signature, your surname and other names.

The Paper Reference is shown towards the top left-hand corner of the page. If more than one Paper Reference is shown, you should write the one for which you have been entered.

Answer NINE questions in the spaces provided in this question paper. You must answer Section 1 and *either* Section B: Biology *or* Section H: Biology (Human)

Show all the steps in any calculations and state the units. Calculators may be used.

Include diagrams in your answers where these are helpful.

Additional Answer Sheets may be used.

Information for Candidates

The marks for individual questions and the parts of questions are shown in round brackets: e.g. (2).

You must answer 9 questions in this question paper. There are no blank pages.

The total mark for this paper is 70.

Advice to Candidates

You will be assessed on your ability to organise and present information, ideas, descriptions and arguments clearly and logically, taking account of your use of grammar, punctuation and spelling.

For examiner's use only

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For Team Leader's use only

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| Question number | Leave Blank |
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| H7 | |
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| H9 | |
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| Total | |

**You must answer Section 1 and
EITHER Section B: Biology OR Section H: Biology (Human)**

Section 1

Answer ALL FOUR questions in this section.

1. (a) State *three* characteristic features of gas exchange surfaces.

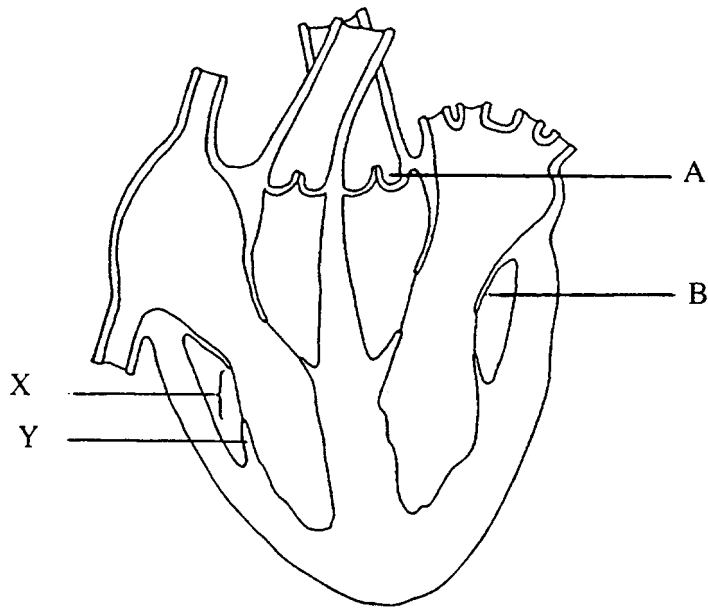
- 1
- 2
- 3 **(3)**

(b) Describe how the process of inspiration (breathing in) takes place in a mammal.

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-
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- **(3)**

(Total 6 marks)

2. The diagram below shows a section of a human heart at a specific stage in the cardiac cycle.



(a) Name the parts labelled A and B.

A

B

(2)

(b) Name the stage of the cardiac cycle shown in the diagram and give TWO reasons for your choice.

Name of stage

Reason 1

.....

Reason 2

.....

(3)

(c) Give ONE function of each of the parts X and Y.

X

Y

(2)

(Total 7 marks)

3. Records of human fertility for the period 1930 to 1990 have shown changes in the sperm counts of normal men.

The table below summarises the changing percentage of men with high or low sperm counts over the period of sixty years.

High sperm count more than 100×10^4 sperm cm^{-3}

Low sperm count less than 20×10^4 sperm cm^{-3}

| Time period | Men with high sperm counts / % | Men with low sperm counts / % |
|-------------|--------------------------------|-------------------------------|
| 1930 – 1950 | 50 | 5 |
| 1951 – 1960 | 45 | 4 |
| 1961 – 1970 | 28 | 14 |
| 1971 – 1980 | 21 | 11 |
| 1981 – 1990 | 15 | 18 |

- (a) Describe the changes in the percentage of men with high sperm counts during the period 1930 to 1990.

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(2)

- (b) Compare the figures for men with low sperm counts with those for men with high sperm counts during the same period.

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(3)

- (c) Explain why it is necessary for large numbers of sperms to be produced when only one sperm is required to bring about fertilisation.

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(2)

- (d) Exposure of pregnant women to high levels of certain oestrogens during early pregnancy can result in reproductive disorders in their male offspring.

It appears that a number of compounds in the environment can mimic the action of oestrogens when ingested. Such compounds, termed oestrogenic chemicals, are found in pesticides, such as DDT and PCBs, and also in the breakdown products of some detergents. They accumulate in the fatty tissue and have the same effect as oestrogens, which play a major role in the menstrual cycle.

- (i) Describe the normal role of oestrogens in the menstrual cycle.

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(3)

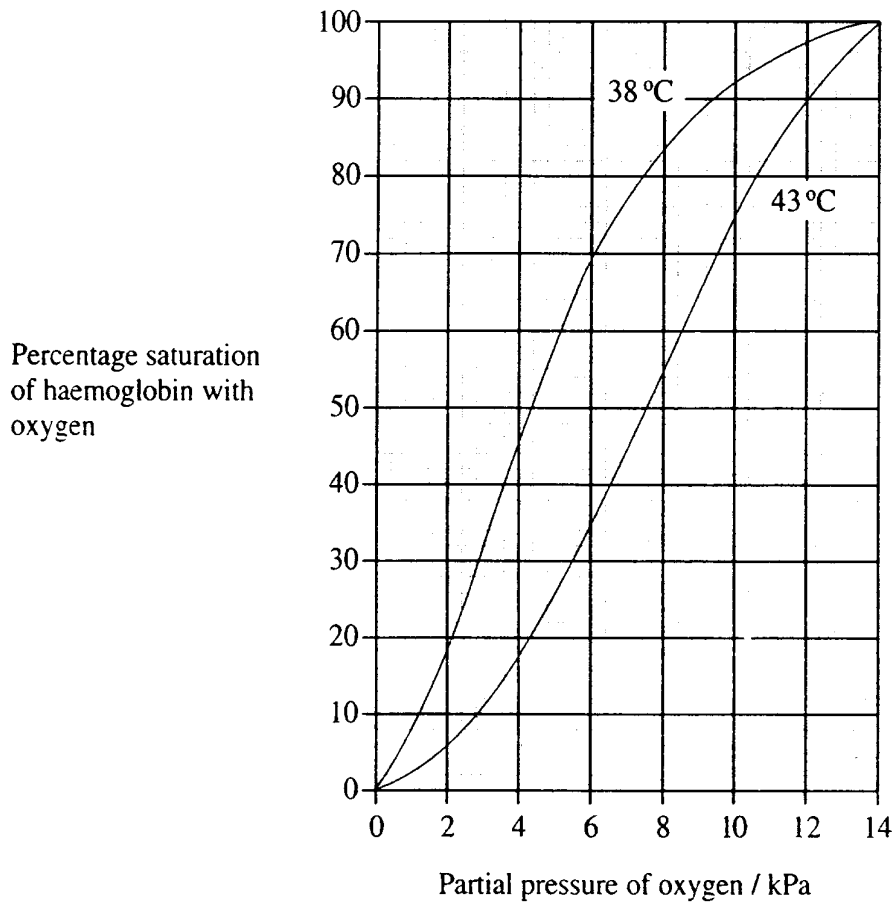
- (ii) Suggest how the oestrogenic chemicals pass from the mother to the developing fetus.

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(3)

(Total 13 marks)

4. The graph below shows the oxygen dissociation curve of haemoglobin from a mammal at two different temperatures, 38 °C and 43 °C.



- (a) From the graph, find the percentage saturation of haemoglobin in blood from an area of the body where the temperature is 43 °C and the partial pressure of oxygen is 4 kPa.

..... (1)

- (b) Blood that is fully (100%) saturated with oxygen carries 105 cm³ of oxygen in 1 dm³ (litre) of blood.

Calculate the volume of oxygen released from 1 dm³ of blood when blood that has become 90% saturated at 38 °C reaches a part of the body where the temperature is 43 °C and the partial pressure of oxygen is 4 kPa. Show your working.

Volume of oxygen (3)

- (c) Suggest how this effect of temperature on the oxygen dissociation curve of haemoglobin might be advantageous to the mammal.

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(2)

- (d) On the graph, draw the dissociation curve for fetal haemoglobin at a temperature of 38 °C.

(2)

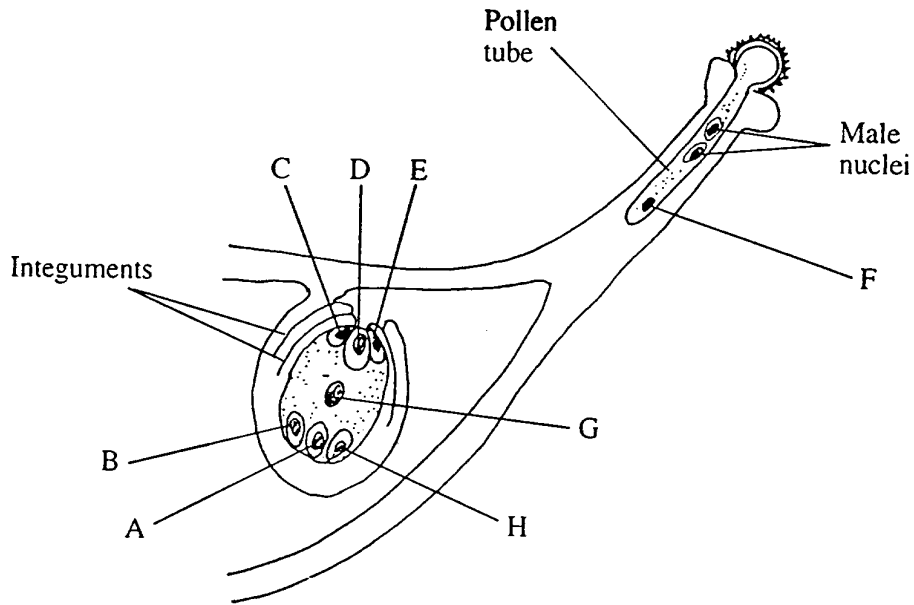
(Total 8 marks)

**You must answer EITHER Section B: Biology which begins on page 8
OR Section H: Biology (Human) which begins on page 16**

Section B: Biology

Answer ALL FIVE questions in this section.

B5. (a) The diagram below shows a germinating pollen grain and a mature ovule from an insect pollinated flower. Some nuclei have been labelled.



Give the letter of the nucleus which fuses with a male nucleus to form each of the following.

The zygote

The endosperm

(2)

(b) Give TWO ways in which the structure of an insect pollinated flower differs from that of a wind pollinated flower or a grass.

1

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2

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(2)

(c) Describe ONE mechanism which prevents self-fertilisation in flowering plants.

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(2)

(Total 6 marks)

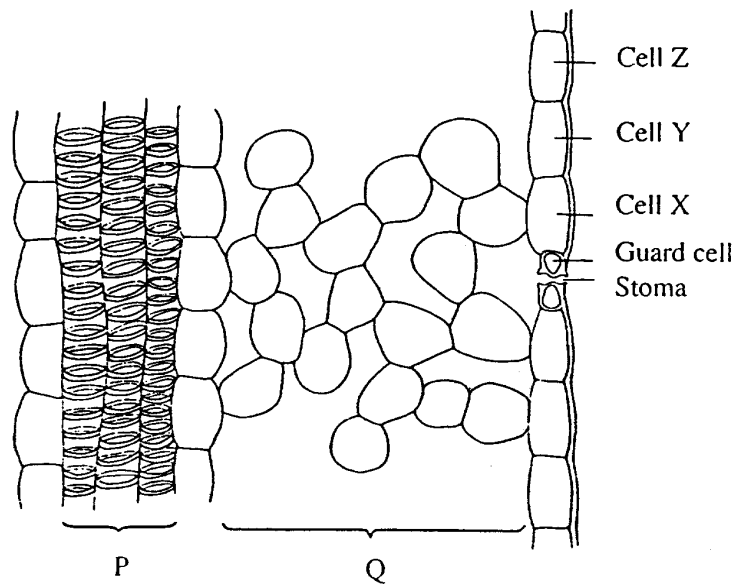
B6. The statements below refer to the structure and functions of xylem vessels and phloem sieve tubes in plants.

If the statement is correct place a tick (✓) in the appropriate box and if the statement is incorrect place a cross (✗) in the appropriate box.

| Statement | Xylem vessels | Phloem sieve tubes |
|---|---------------|--------------------|
| Possess living contents | | |
| Provide support | | |
| Composed of cells fused together end to end | | |
| Walls contain lignin | | |

(Total 4 marks)

B7. The diagram below shows some of the cells involved in the loss of water from part of a leaf.



(a) Name the tissues labelled P and Q on the diagram.

P

Q

(2)

(b) The table below shows the concentrations of potassium ions in some of the cells shown in the diagram when the stoma is open and when the stoma is closed.

| Cell | Concentration of potassium ions / arbitrary units | |
|------------|---|------------|
| | Stoma closed | Stoma open |
| Guard cell | 95 | 448 |
| Cell X | 156 | 293 |
| Cell Y | 199 | 98 |
| Cell Z | 448 | 73 |

Describe the changes that take place in the concentrations of potassium ions in cells X, Y and Z when the stoma opens.

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(2)

- (c) Explain how the changes in potassium ion concentration are related to the mechanism for the opening of the stoma.

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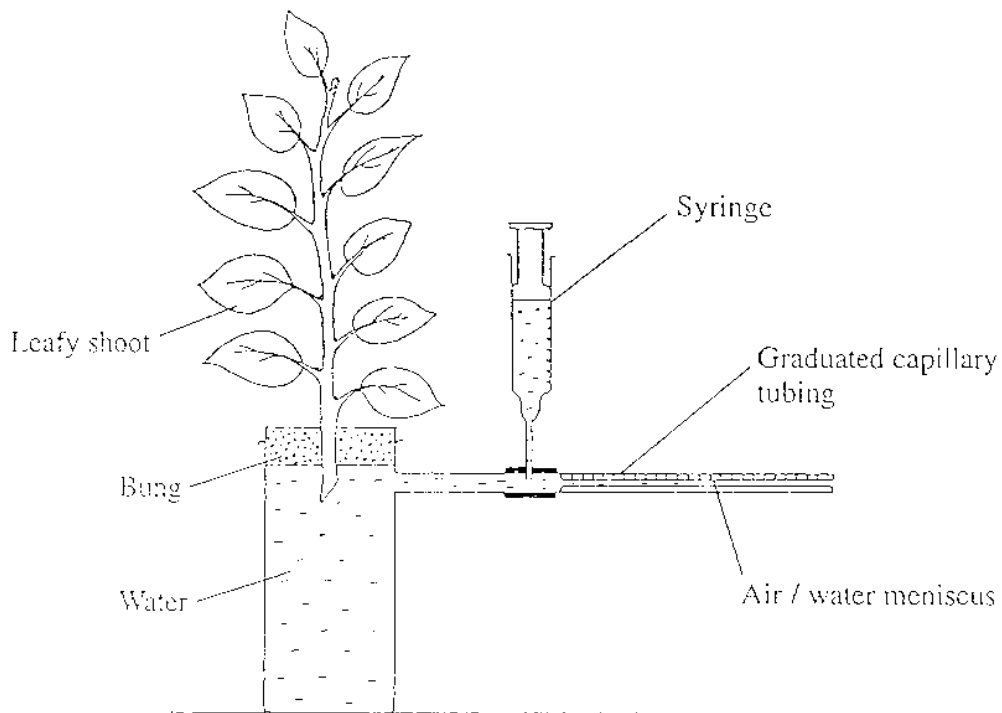
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(3)

(Total 7 marks)

B8. The uptake of water by a leafy shoot can be investigated using a potometer as shown in the diagram below.



(a) What assumption is made when this apparatus is used to investigate the rate of transpiration?

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(1)

(b) State TWO precautions which must be taken when setting up and using this apparatus.

1

.....

2

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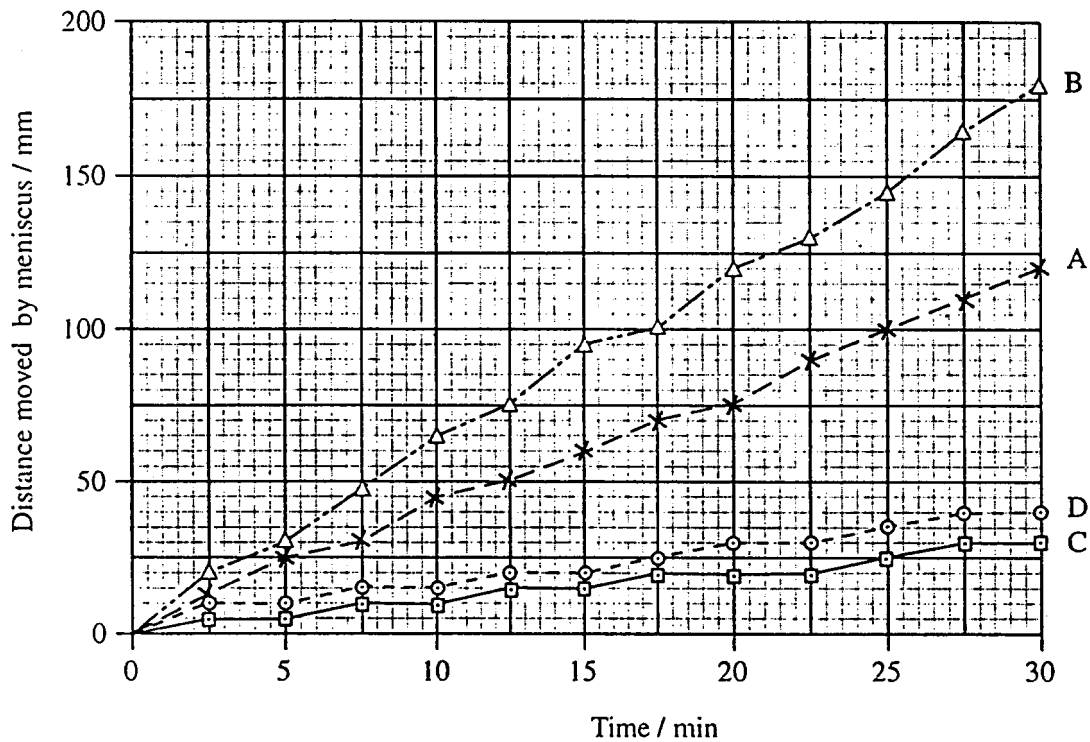
(2)

(c) Using this apparatus, four experiments were carried out with the same shoot in the order given below.

- A Still air, leaves untreated
- B Moving air, leaves untreated
- C Still air, lower surface of leaf covered with grease
- D Moving air, lower surface of leaf covered with grease

Temperature and light intensity were kept constant during the investigation.

The results are shown in the graph below.



The mean rate of water uptake during experiment A was 3.2 mm³ per minute.

The cross-sectional area of the bore of the capillary tube is 0.8 mm². Calculate the mean rate of water uptake by the shoot during experiment B. Show your working.

Rate of uptake
 (3)

(d) Suggest an explanation for the different effects of moving air in experiments B and D.

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(3)

(Total 9 marks)

B9. Give an account of the structural and physiological adaptations shown by invertebrates to the varying oxygen concentrations found in fresh water.

(Total 10 marks)

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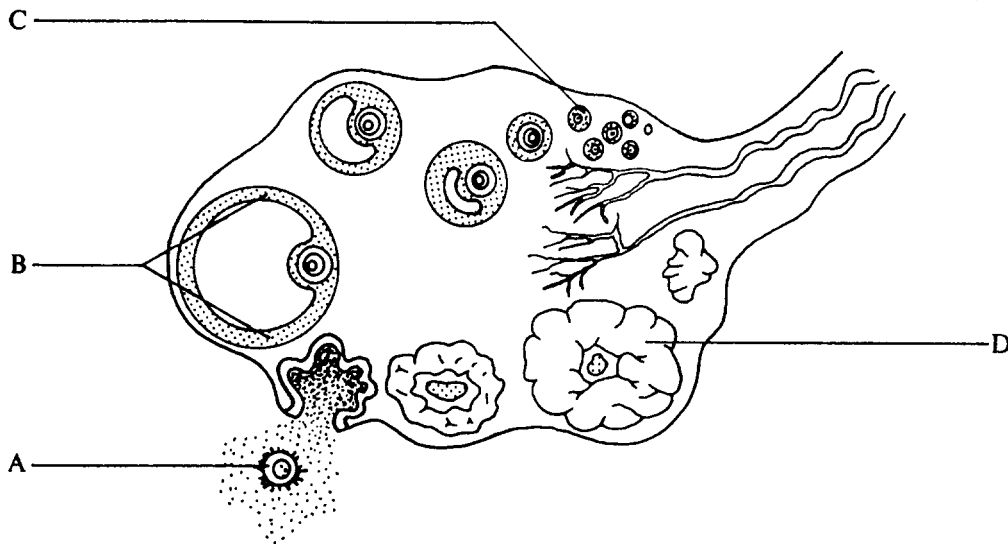
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END

Section H: Biology (Human)

Answer ALL FIVE questions in this section.

H5. The diagram below shows a section of a human ovary.



(a) Name the structures labelled A, B and C.

A

B

C

(3)

(b) Name the type of cell division which gave rise to structure C.

.....

(1)

(c) Name the hormone, secreted by the pituitary gland, which is responsible for the development of structure B.

.....

(1)

(Total 5 marks)

H6. (a) Explain what is meant by osteoporosis.

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(3)

(b) Explain how osteoarthritis differs from osteoporosis.

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(2)

(Total 5 marks)

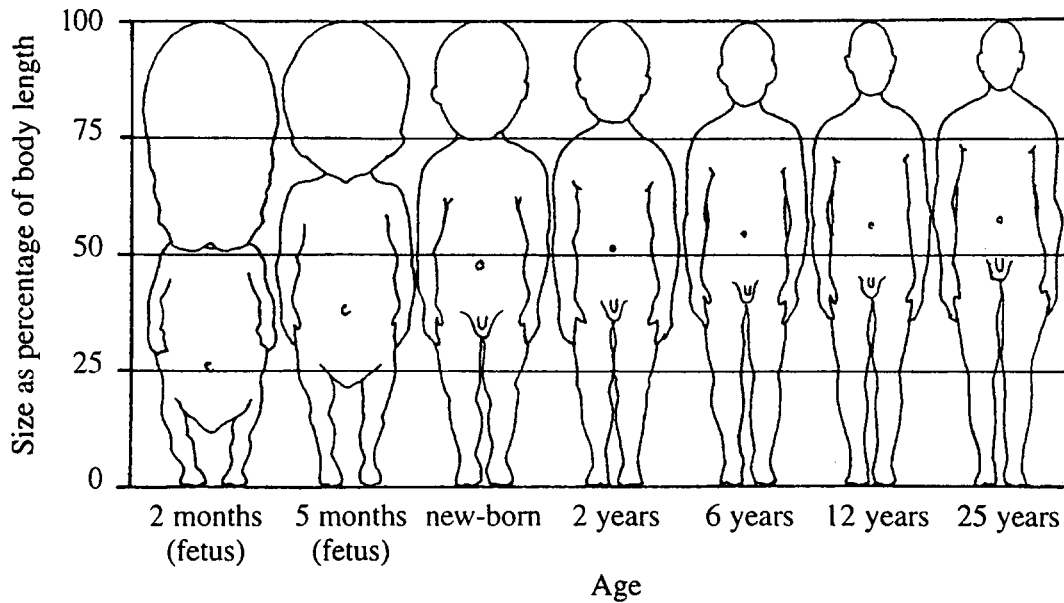
H7. The statements below refer to two types of epithelial tissue found in humans.

If the statement is correct place a tick (✓) in the appropriate box and if the statement is incorrect place a cross (✗) in the appropriate box.

| Statement | Squamous epithelium | Cuboidal epithelium |
|---|---------------------|---------------------|
| Cells are bonded to a basement membrane | | |
| Cells are wider than they are tall | | |
| Nuclei are flattened | | |
| All cells possess cilia | | |

(Total 4 marks)

H8. The diagram below represents changes in the relative length of different parts of the body during the growth of a human male.



(a) Compare the relative size of the head of a two month fetus with that of a new born baby.

.....

(1)

(b) Suggest *two* reasons for the difference you describe.

1

.....

2

.....

(2)

(c) Compare the relative size of THREE different parts of the body of a six year old and a twenty five year old.

- 1
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 - 2
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 - 3
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- (3)**

(d) Give TWO factors that influence the growth of the body from six to twenty five years.

- 1
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 - 2
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- (2)**

(e) Human growth can be studied by measuring changes in height or changes in mass. Explain why neither of these is an ideal method for measuring growth.

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- (4)**

(Total 12 marks)

H9. Give an account of the adaptations of humans to life at extremes of temperature.
(Total 10 marks)

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Three lined pages

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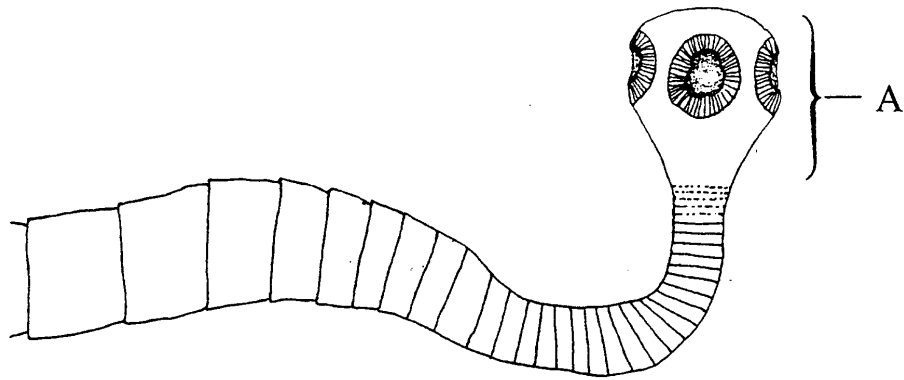
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1. The diagram below shows a part of the beef tapeworm *Taenia saginata*.



(a) Explain the importance of the part labelled A in the life of the tapeworm.

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(2)

(b) Describe how the tapeworm obtains its nutrition.

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(2)

(c) How does the nutrition of *Rhizopus* differ from that of the tapeworm?

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(2)

(Total 6 marks)

2. Between 1882 and 1952 the proportion of the Earth's land surface classified as desert increased from 9.4% to 23.3%. The shift to desert is still going on. The most affected areas are the semi-arid lands around the fringes of deserts, such as the Sahel, the belt of land lying to the south of the Sahara Desert in Africa (Figure 1). Rainfall records from the Sahel (Figure 2) show that rainfall has been below average for the last 20 years and the decline is getting worse. The degradation of semi-arid land into desert is called desertification.

Figure 1 Map of Africa and the Middle East showing the extent of desert and arid zones, with areas under threat from desertification.

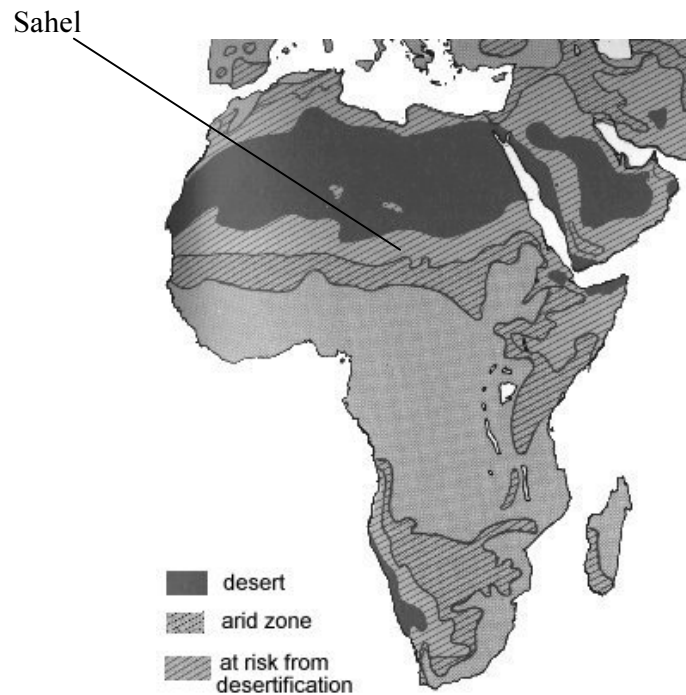
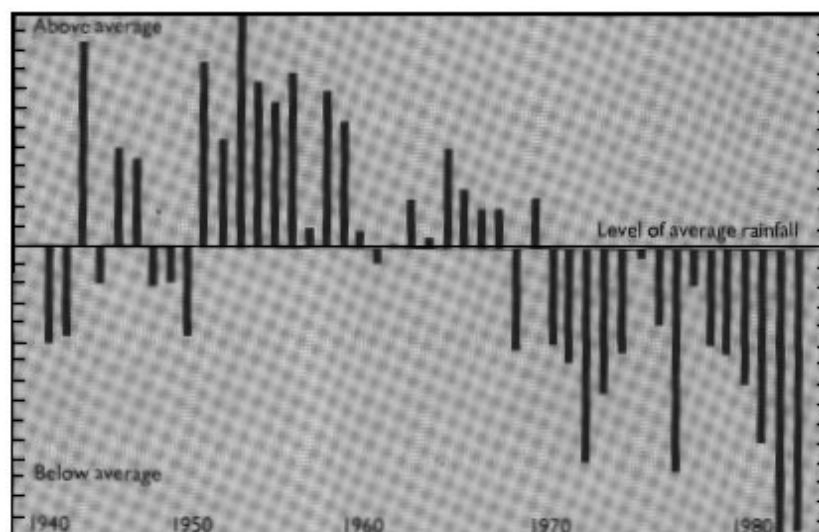


Figure 2 The rainfall pattern in the Sahel. The bars show the departure from the normal rainfall.



Diagrams from Atlas of living world, Weidenfeld and Nicolson

(a) Describe the effects of overgrazing and the collecting of wood for fuel on semi-arid land.

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(3)

(b) People living in the Sahel have kept herds of sheep and goats for hundreds of years. Suggest *one* reason why overgrazing has become a problem in the last 20 years.

.....
.....

(1)

(c) Figure 2 shows that the rainfall in the Sahel between 1950 and 1968 was above average. How would the increased rainfall have affected farming in the Sahel?

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(2)

(d) Describe the effects of the drought which occurred during the 1970s.

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(2)

(e) How might the changes to the global climate have affected desertification in the Sahel?

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(2)

(f) Describe how people can protect their land from desertification.

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(2)

(Total 12 marks)

3. Study the passage and data below and then answer the questions that follow.

Acid rain and its effect on fresh water and fisheries

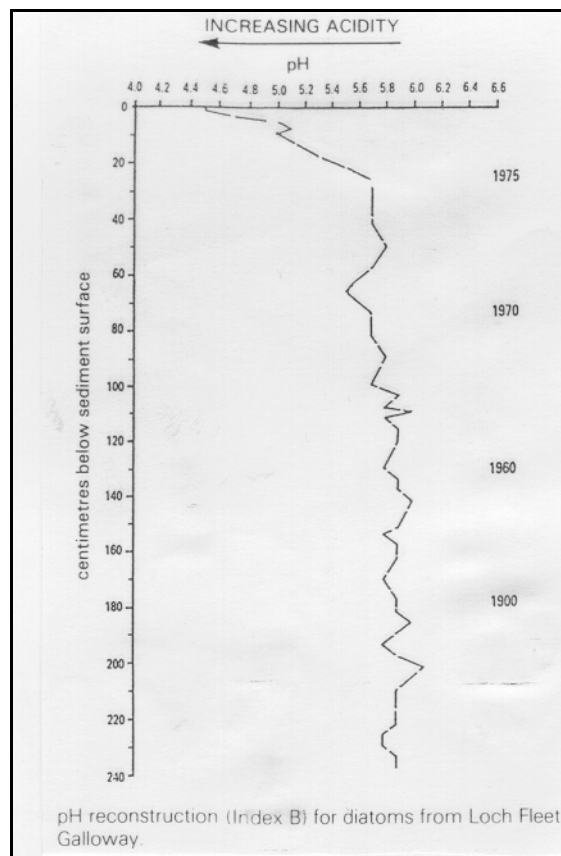
It is difficult to obtain direct evidence that, as a result of the increased acidity of precipitation, certain lakes and streams with fishery problems are now more acid than they were in the past. Nevertheless, indirect evidence that surface water acidification has occurred comes from the remains of diatoms in lake sediments.

Historical records of pH are rare and subject to a great deal of uncertainty, since analytical methods have changed over the years. Moreover, pH is naturally variable on a daily and annual basis and occasional spot measurements can give a misleading impression. Diatom analysis provides a way round these difficulties. Diatoms are microscopic algae which live free floating in the lake water. They have skeletons made of silica which are resistant to decay. When a diatom dies it sinks to the bottom of the lake where the remains accumulate as sediment.

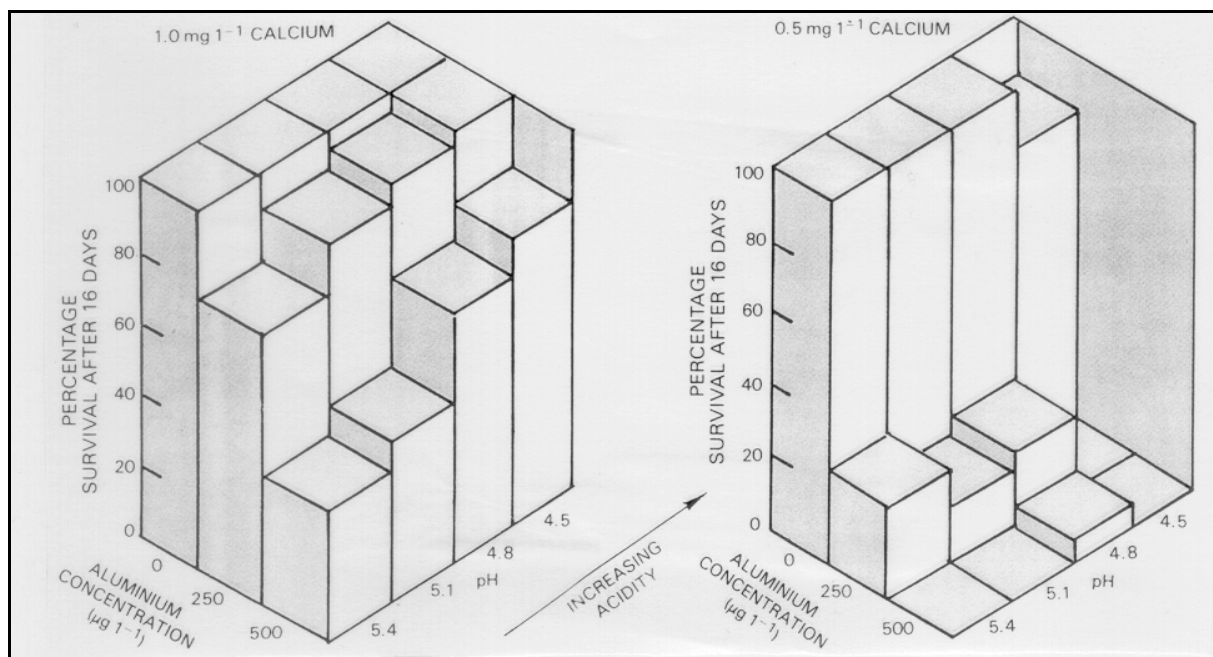
Different diatom species have different pH preferences. Those preferring the least acid water are called alkalibiontic. Acidibiontic species prefer more acidic water. If a core of the lake sediment is taken and it is discovered that alkalibiontic diatoms predominate in the deepest layers and they are replaced by more acid-loving species towards the surface of the sediment, that is a good evidence that the lake has acidified over historical time. Moreover, if the sediments can be dated, by radiotracer methods for example, then the acidification can be correlated in time to events such as the Industrial Revolution and forest clearance. Studies were made of the diatoms in the sediments of Loch Fleet in Galloway, an acid lake.

It may take a long time, following the reduction in the acidity of the precipitation, before the recovery of the surface water quality is sufficient to allow restoration of fish stocks. Recovery can be speeded up by the application of calcium to neutralise the acid and suppress the release of aluminium. Experiments were conducted involving the application of calcium in the form of 300 tonnes of limestone to soils surrounding the lake during April 1986. The subsequent changes in the levels of aluminium and calcium in the water were monitored over the next year.

Figure 1. The pH reconstruction for diatoms from Loch Fleet.



Figures 2a and 2b. The effect of varying levels of calcium application on the survival of brown trout fry (newly hatched fish) in a range of pH, aluminium and calcium concentrations.



Text and data adapted from *Freshwater acidification and fisheries decline* by D.J.A Brown, CEBG Research (1987)

(a) How is acid rain formed?

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(4)

(b) Describe the changes in the acidity of the water of Loch Fleet over the last 100 years. Explain why these changes occurred.

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(4)

(c) The use of diatoms may not be a fool-proof method of studying the changes in pH. Suggest ONE way in which the data could be misleading.

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(1)

(d) Describe the effect of aluminium ions on fresh water organisms.

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(3)

(e) Study the information provided in Figures 2a and 2b. Describe the effect of the calcium treatment on the survival of the brown trout fry.

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(4)

(f) Suggest why it is preferable to add the limestone to the surrounding soils rather than directly to the surface of the water.

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(2)

(g) Describe TWO methods used by European countries to reduce the production of acid rain.

1

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2

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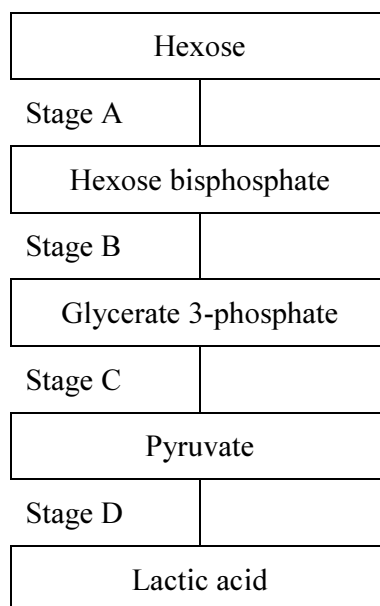
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(Total 20 marks)

END

Section 1

1. The diagram below shows some of the stages in anaerobic respiration in a muscle.



(a) Name the process shown by stages A to C.

..... (1)

(b) State where in a cell this process occurs

..... (1)

(c) Give ONE use of ATP in cells.

..... (1)

(d) At which of the stages in the diagram is ATP used?

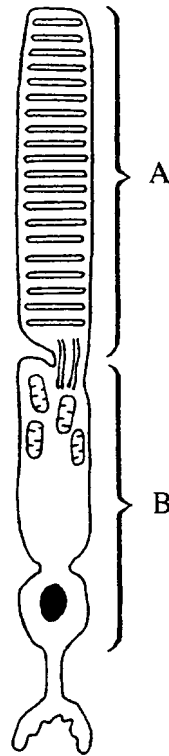
..... (1)

(e) $\text{NADH} + \text{H}^+$ is a reduced coenzyme which is involved in anaerobic respiration. At which stage is $\text{NADH} + \text{H}^+$ oxidised?

..... (1)

(Total 5 marks)

2. The diagram below shows a rod cell from the retina of a mammal.



(a) Name the parts labelled A and B.

A

B

(2)

(b) State the location of most of the rod cells in the human retina.

.....

(1)

(c) Give the name of the light sensitive pigment contained in the rod cells.

.....

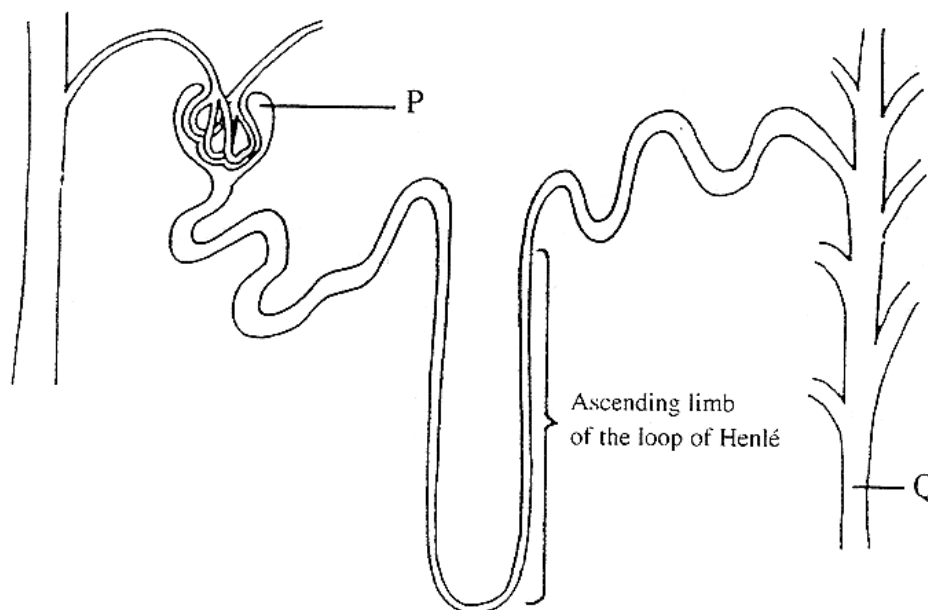
(1)

(d) Use the letter P to label on the diagram the region of the rod cell in which this pigment is located.

(1)

(Total 5 marks)

3. The diagram below shows the simplified structure of a kidney tubule (nephron).



(a) The table below shows the quantities of water and urea passing through P and Q in a period of 24 hours. The table also shows the quantities and percentages reabsorbed during the same period.

Complete the table by writing the correct figures in the boxes labelled (i), (ii), (iii) and (iv).

| Substances | Quantity passing through P | Quantity passing through Q | Quantity reabsorbed | Percentage reabsorbed |
|------------|----------------------------|----------------------------|-----------------------|-----------------------|
| Water | 180 dm ³ | 1.5 dm ³ | 178.5 dm ³ | (i) |
| Urea | 53 g | 25 g | (ii) | (iii) |
| Glucose | 180 g | (iv) | 180 g | 100 |

(4)

- (b) Describe how the ascending limb of the loop of Henlé is involved in adjusting the concentration of the filtrate as it passes through the medulla in the kidney.

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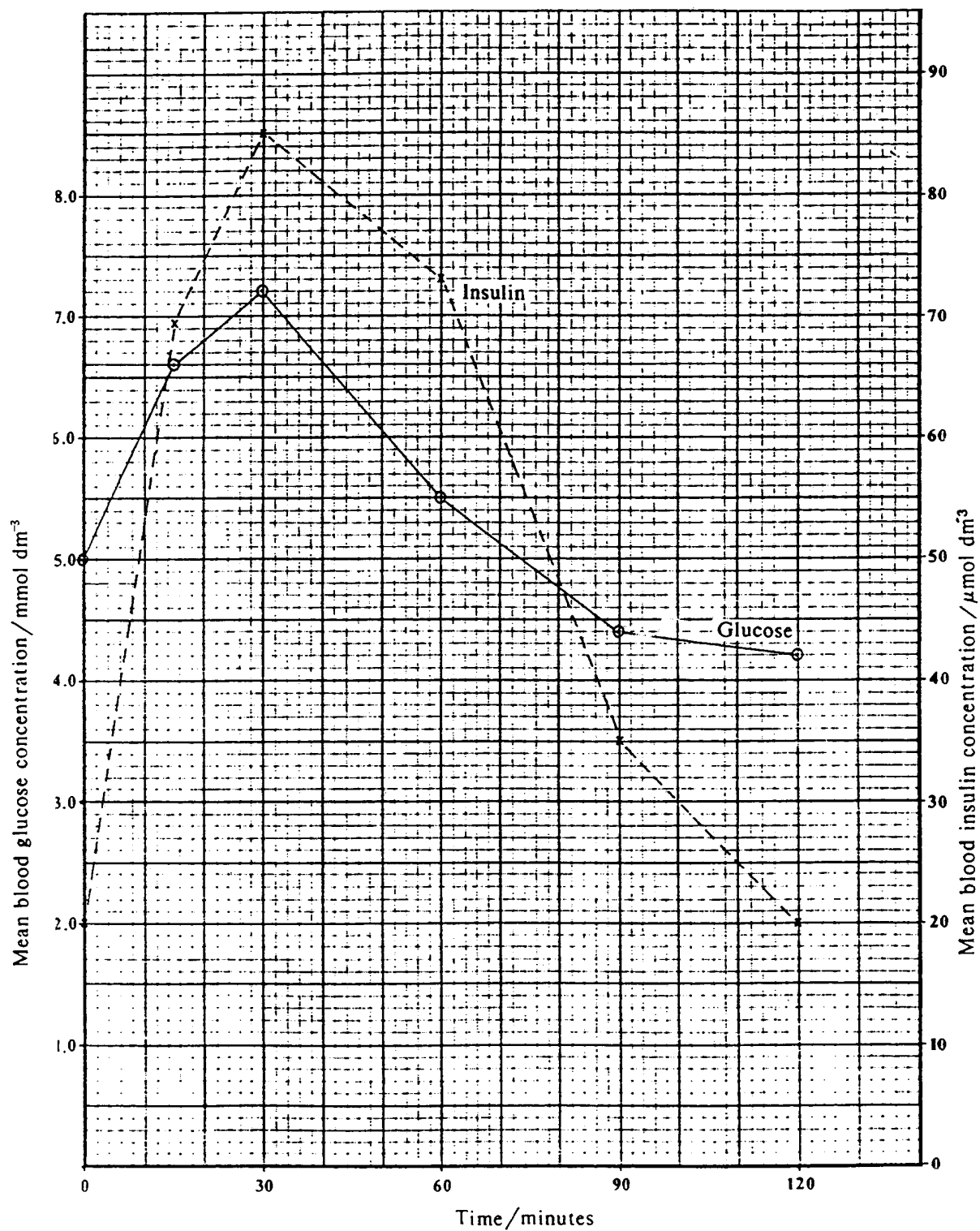
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(4)

(Total 8 marks)

4. An experiment was carried out to investigate the relationship between the concentrations of glucose and insulin in the blood of healthy people.

At the start of this experiment 34 volunteers each ingested a syrup containing 50 g of glucose. The concentration of glucose and insulin was determined in blood samples at intervals over a period of 2 hours. The results shown in the graph below are mean values for the group of volunteers.



- (a) From the graph, find the mean concentration of insulin 100 minutes after the start of the experiment.

.....
(1)

- (b) Describe and suggest an explanation for the changes in the concentration of glucose during the following time intervals.

- (i) 0 to 30 minutes

.....
.....
.....
.....
(2)

- (ii) 30 to 120 minutes

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.....
.....
.....
(2)

- (c) Discuss the relationship between the concentrations of glucose and insulin as shown by this graph.

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(3)

- (d) At the start of a period of prolonged exercise, the blood glucose level begins to fall. Describe and explain how the level is controlled as the exercise continues.

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(4)

(Total 12 marks)

5. Give an account of the transmission of a nerve impulse along an axon.

(Total 10 marks)

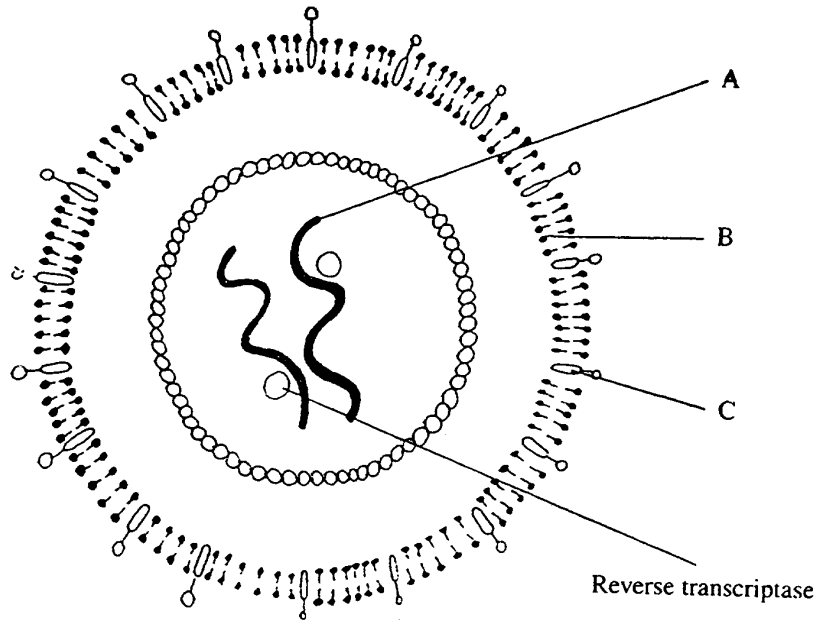
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Option A: Microbiology and biotechnology

A1. The diagram below shows the structure of a human immunodeficiency virus (HIV).



(a) Name the parts labelled A,B and C.

- A
 - B
 - C
- (3)**

(b) State the function of the reverse transcriptase.

-
 -
- (1)**

(c) Explain the meaning of the term latency in the replication cycle of this virus.

-
 -
 -
 -
- (2)**

(Total 6 marks)

A2. Read the following passage on Gram staining, and then write on the dotted lines the most appropriate word or words to complete the account.

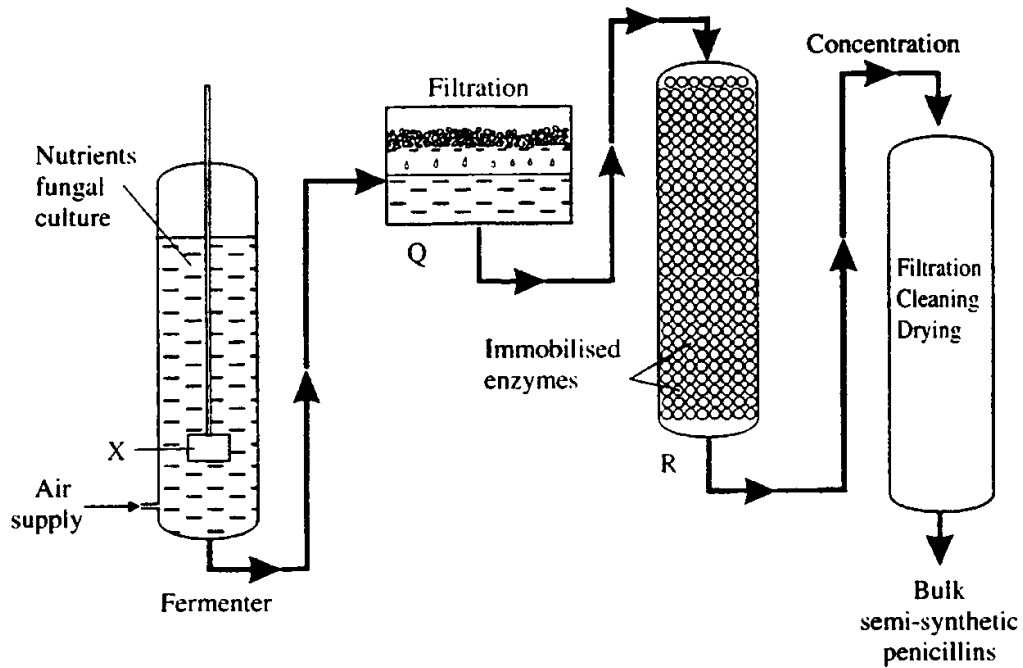
Gram positive and Gram negative bacteria differ in their ability to keep a stain in their cell walls. A slide of bacteria is first flooded with a suitable stain such as

..... All bacteria absorb this stain, which is then fixed with Gram's before being decolourised with

Gram positive bacteria retain the stain complex, but Gram negative do not. Counterstaining with red stain, such as causes Gram negative bacteria to absorb it and become red. Gram positive bacteria remain in colour.

(Total 5 marks)

A3. Penicillin is an antibiotic which is derived from the fungus *Penicillium chrysogenum*. The antibiotic can be produced on a commercial scale as shown in the diagram below.



(a) What is the purpose of structure X?

.....

 (1)

(b) Why is air supplied to the fermenter?

.....

 (1)

(c) Explain the purpose of the filtration carried out at Q.

.....

 (2)

(d) Suggest ONE reason for using enzymes at R.

.....

 (1)

(e) Suggest why they are used as immobilised enzymes.

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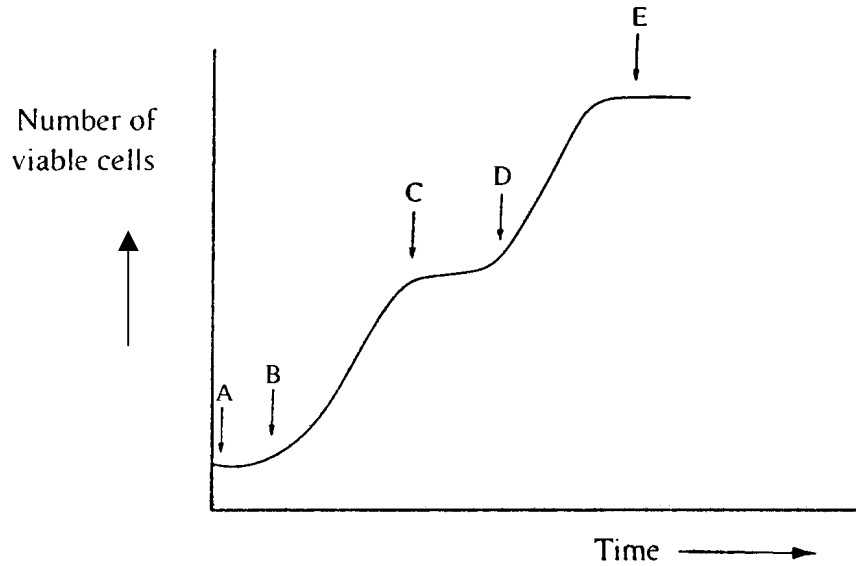
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(2)

(Total 7 marks)

A4. An experiment was carried out to investigate the growth of a certain species of aerobic bacterium. A broth medium containing both glucose and lactose was inoculated with a culture of the bacterium and maintained at a constant temperature of 30 °C for 24 hours. The number of bacterial cells was determined each hour using the dilution plating method.

The results are shown in the graph below.



(a) Describe what is happening between points A and B on the graph.

.....

.....

.....

.....

(2)

(b) Suggest explanations for the pattern of growth of the bacteria between each of the following time intervals.

(i) B to C

.....

.....

.....

.....

(2)

(ii) C to D

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.....

(2)

(iii) D to E

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(2)

(c) Suggest why the dilution plating method was used to determine the numbers of bacterial cells.

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(2)

(d) Explain why it is necessary to carry out serial dilutions.

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(2)

(Total 12 marks)

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Section 1

Questions 1 to 5 are identical to Paper 6104/01 (Unit 4A)

Option B: Food science

B1. Read through the following account of food additives, then write on the dotted lines the most appropriate word or words to complete the passage.

Additives are commonly used in the commercial treatment of food. For generations, foods have traditionally been preserved by the addition of sugar, alcohol or

..... Nowadays, most processed foods contain additives.

These include permitted colourings, antioxidants such as

and, and flavour enhancers such as

.....

There is doubt about the safety of some additives used and many people believe that they are the cause of hyperactivity in children and in sensitive individuals.

(Total 5 marks)

B2. Body mass index (BMI) is used as a measure of obesity, which can be an indicator of long term health.

Five students agreed to have their mass and height measured to determine their BMI. The results are shown in the table below.

| Student | Mass / kg | Height / m | BMI |
|---------|-----------|------------|-------|
| A | 59.67 | 1.75 | 19.48 |
| B | 65.03 | 1.70 | 22.50 |
| C | 63.92 | 1.65 | 23.48 |
| D | 66.56 | 1.60 | 26.00 |
| E | 58.80 | 1.55 | E |

For healthy people, the BMI should lie in the range from 20 to 25. A BMI outside this range is regarded as a potential health risk.

(a) Calculate the BMI for student E. Show your working.

BMI =
(2)

(b) State which of the students could be considered to be overweight.

.....
(1)

(c) Suggest THREE factors which should be taken into account when interpreting BMI values.

1

2

3

(3)

(Total 6 marks)

B3. The sequence below shows some essential steps in the manufacture of yoghurt from milk.

- A Homogenisation of the milk (breaks up large fat globules)
- B Pasteurisation (heated to 72 °C for 10 seconds)
- C Fermentation (starter culture added)
- D Stirring and cooling
- E Addition of flavourings and colourings
- F Packaging

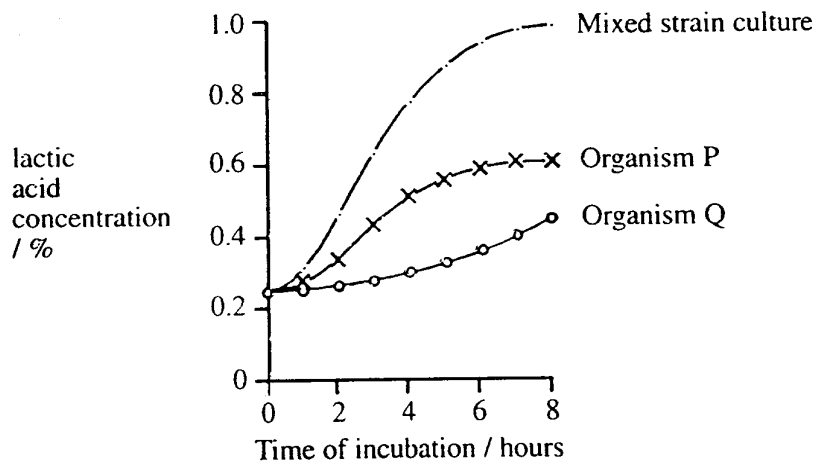
(a) Why is pasteurisation of the milk carried out at step B?

.....

 (1)

(b) At step C, a starter culture is added to bring about the fermentation. During this stage lactose in the milk is broken down, resulting in the formation of lactic acid. Two organisms, P and Q, are commonly used in starter cultures. Each one on its own is capable of bringing about the fermentation, but they may be used together.

The graph below shows the rate of lactic acid production when the two organisms are used separately (single strain cultures) and when they are used together (mixed strain culture).



Name the two organisms commonly used in starter cultures.

1
 2
 (2)

(c) Suggest which type of starter culture is the most suitable, giving a reason for your answer.

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(2)

(d) Explain the importance of lactic acid in the production of yoghurt.

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(2)

(e) State why, at step D, the yoghurt is cooled rapidly to 5 °C.

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(1)

(Total 8 marks)

B4. An investigation was carried out into the effects of different methods of packaging on the loss of mass in apples. Freshly picked apples were divided into three groups, A, B and C, each containing six apples. Group A was left unwrapped, group B was placed in a paper bag and group C was placed in a pack wrapped in polythene.

Each group of apples was weighed initially, and in the case of groups B and C allowance was made for the mass of the packaging. The apples were kept in conditions of constant low humidity and a temperature of 15 °C. The apples were then weighed at intervals of 2 days and the mass of each group was recorded for a period of ten days.

The results are shown in the table below.

| Time / days | Mass of apples / g | | |
|-------------|----------------------|---------------------------|--|
| | Group A Unwrapped | Group B In a paper bag | Group C In a pack wrapped in polythene |
| 0 | 730.0 | 732.0 | 735.0 |
| 2 | 719.9 | 723.4 | 729.0 |
| 4 | 694.3 | 709.5 | 721.3 |
| 6 | 663.7 | 694.1 | 714.0 |
| 8 | 636.5 | 686.6 | 705.0 |
| 10 | 620.5 | 680.5 | 698.2 |

(a) Calculate the percentage loss in mass of the unwrapped apples over the period of ten days. Show your working.

Percentage loss
(2)

(b) Explain why the unwrapped apples lost mass during the ten day period.

.....

(3)

- (c) Compare the results obtained for the apples placed in a paper bag with those for the unwrapped apples. Suggest a reason for any differences you observe.

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.....
.....

(2)

- (d) Give TWO advantages of using polythene wrapping for packaging apples that are sold in shops and supermarkets.

1

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2

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(2)

- (e) Plastic films with different permeability to gases can be used to create a 'modified atmosphere' inside a package.

Suggest why a modified atmosphere with increased carbon dioxide and lowered oxygen concentration can help extend the shelf life of fresh fruit and vegetables.

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.....

(2)

(Total 11 marks)

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Section 1

Questions 1 to 5 are identical to Paper 6104/01 (Unit 4A)

Option C: Human health and fitness

C1. Read through the following passage on coronary heart disease, and then write on the dotted lines the most appropriate word or words to complete the passage.

One of the major risk factors for coronary heart disease is
..... The underlying cause of coronary heart disease is
usually atherosclerosis. Fatty deposits are laid down within the inner coat of the
..... arteries. Atherosclerosis starts as fatty streaks that
develop into uneven patches called The uneven
patches roughen the surface of the arteries causing blood
..... to develop. These may block small arteries so that part
of the heart muscle is partially deprived of This in turn
may lead to the of part of the heart muscle causing a
heart attack.

(Total 6 marks)

C2. An investigation was carried out into the effects of exercise on breathing rate and the volume of each breath. The breathing rate and volume of a healthy young man were measured at rest and then after using a bicycle exercise machine. After each minute's exercise his work rate was increased by increasing the load on the wheel of the exercise bicycle. The results are shown in the table below.

| Exercise intensity / watts | Breathing rate / breaths per minute | Volume of each breath / cm ³ |
|----------------------------|-------------------------------------|---|
| 0 (rest) | 14 | 400 |
| 30 | 20 | 750 |
| 75 | 27 | 1000 |
| 100 | 30 | 1250 |
| 150 | 35 | 1500 |
| 200 | 50 | 1600 |

(a) Calculate the volume of air breathed per minute at an exercise intensity of 150 watts. Show your working.

Volume
(2)

(b) Explain why the increase in the volume of each breath is not proportional to the increase in exercise intensity.

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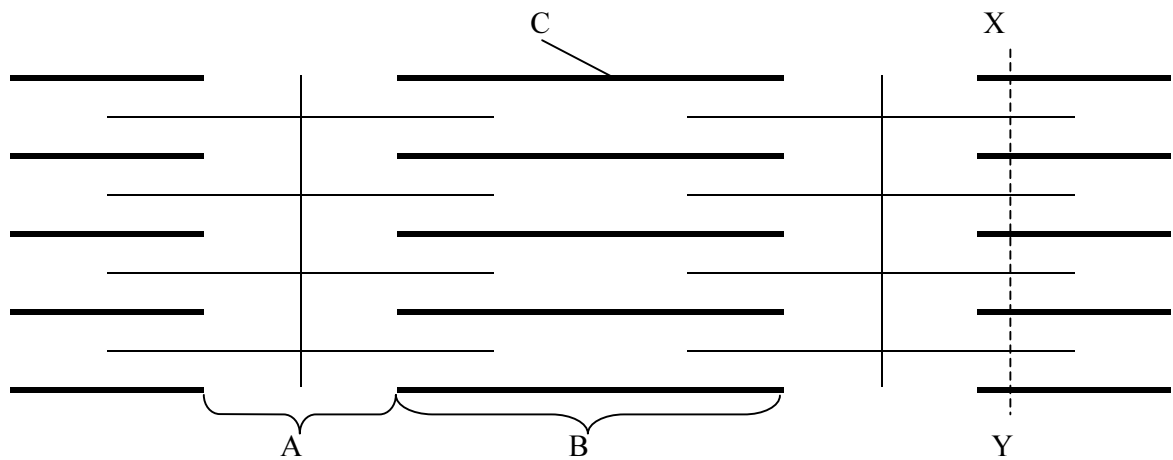
 (3)

(c) State TWO factors, other than exercise, which can affect the rate of breathing.

1
 2
 (1)

(Total 6 marks)

C3. The diagram below shows part of a myofibril of a striated muscle fibre.



(a) Name the regions labelled A and B.

A

B

(2)

(b) Name the protein which makes up part C.

.....

(1)

(c) In the space below, make a drawing to show the appearance of a transverse section of a myofibril as it would be seen in a section across XY.

(2)

(d) Describe the effect of training on muscle size.

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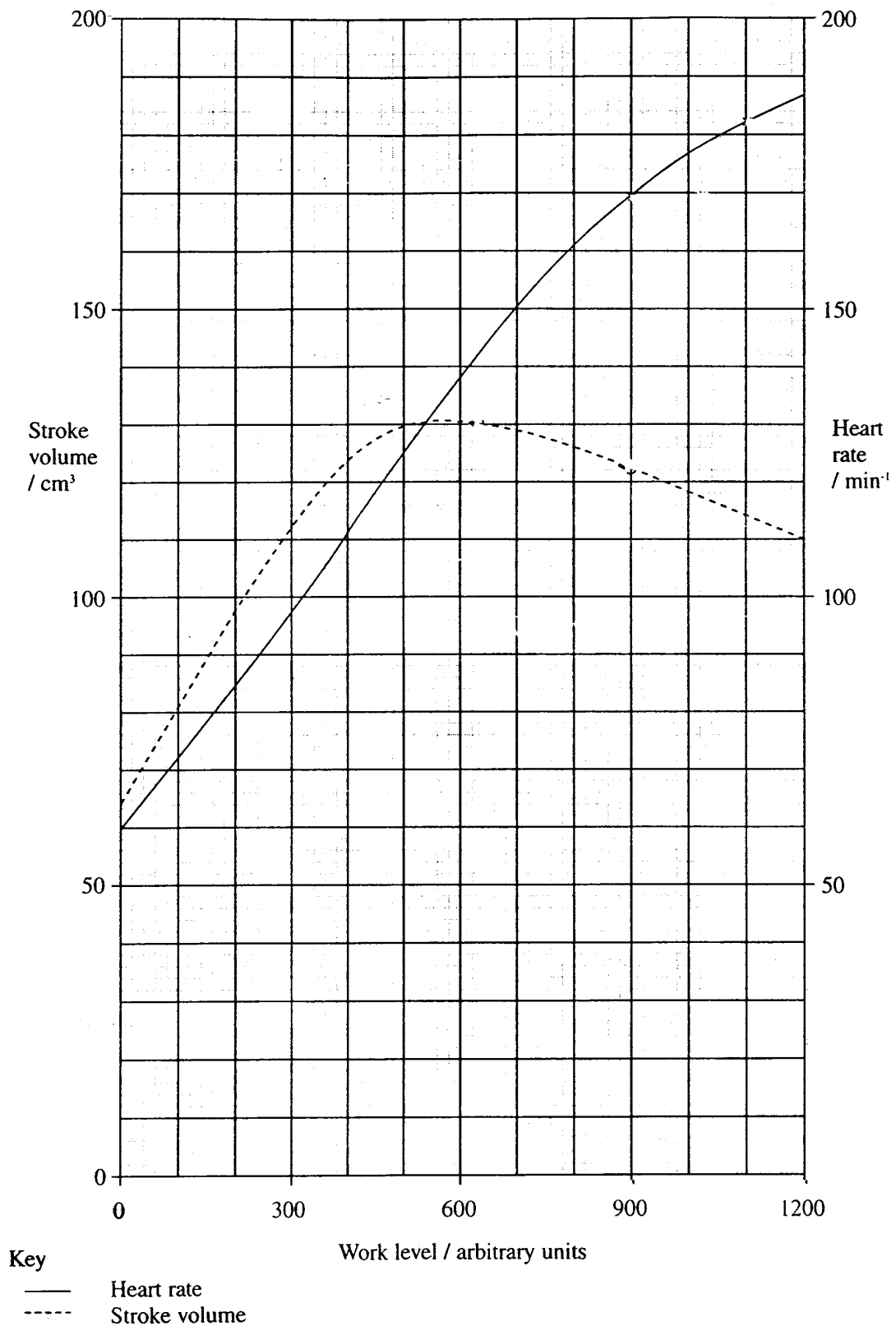
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(3)

(Total 8 marks)

C4. An investigation was carried out on the effect of exercise on heart rate and stroke volume. The heart rate is the number of times the heart beats per minute and the stroke volume is the volume of blood pumped out by the heart each time it beats. The heart rate and stroke volume of a person were measured at different work levels. The results of this investigation are shown in the graph below.



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You must answer EITHER Section B: Biology which begins on this page

OR Section H: Biology (Human) which begins on page 7

You must then answer the Synoptic Section which begins on page 12

Section B: Biology

Answer ALL THREE questions in this section.

B1. The table below gives features of four different kingdoms. Complete the table by writing the name of the kingdom in the boxes.

| Features | Kingdom |
|---|---------|
| Organisms usually consist of a mass of hyphae with cell walls containing chitin. | |
| Heterotrophic, multicellular organisms with nervous coordination. | |
| Multicellular photosynthetic organisms with cellulose cell walls. | |
| Eukaryotic organisms which are often single-celled or consist of groups of similar cells. | |

(Total 4 marks)

- B2.** The statements below refer to some effects of two groups of plant growth substances, auxins and gibberellins.

If the statement is correct place a tick (✓) in the appropriate box and if the statement is incorrect place a cross (✗) in the appropriate box.

| Effect | Auxins | Gibberellins |
|---|--------|--------------|
| Promote cell elongation | | |
| Promote root formation in cuttings and calluses | | |
| Promote fruit ripening | | |
| Inhibit lateral bud development | | |
| Promote the breaking of dormancy in seeds | | |

(Total 5 marks)

B3. An investigation was carried out into the effect of carbon dioxide concentration and light intensity on the productivity of lettuces in a glasshouse. The productivity was determined by measuring the rate of carbon dioxide fixation in milligrams per dm² leaf area per hour.

Experiments were conducted at three different light intensities: 0.05, 0.25 and 0.45 (arbitrary units), the highest approximating to full sunlight. A constant temperature of 22 °C was maintained throughout. The results are given in the table below.

| Carbon dioxide concentration / ppm | Productivity at different light intensities / mg dm ⁻² h ⁻¹ | | |
|------------------------------------|---|------------------------------|-------------------------------|
| | At 0.05 units light intensity | At 0.25units light intensity | At 0.45 units light intensity |
| 300 | 12 | 25 | 27 |
| 500 | 14 | 30 | 36 |
| 700 | 15 | 35 | 42 |
| 900 | 15 | 37 | 46 |
| 1100 | 15 | 37 | 47 |
| 1300 | 12 | 31 | 46 |

(a) For the experiment at 0.25 units light intensity, describe and comment on the effects on the productivity of the lettuces of increasing carbon dioxide concentration in the range (i) 300 to 900 ppm, and (ii) 900 to 1300 ppm.

(i) 300 to 900 ppm

.....

(2)

(ii) 900 to 1300 ppm

.....

(2)

- (b) A carbon dioxide concentration of 300 ppm is approximately equivalent to that in atmospheric air.

For each of the three light intensities, work out the maximum increase in productivity that was obtained compared with that at 300 ppm and use it to calculate the percentage increase in productivity at each light intensity.

- (i) At 0.05 units light intensity:

Maximum increase

Percentage increase

- (ii) At 0.25 units light intensity:

Maximum increase

Percentage increase

- (iii) At 0.45 units light intensity:

Maximum increase

Percentage increase

(3)

- (c) Comment on the effects on productivity of changing light intensity.

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.....

(2)

- (d) Explain why carbon dioxide concentration affects the productivity of plants.

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(3)

(e) State why the temperature should be kept constant during this experiment.

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(1)

(f) Suggest why, even with artificial lighting, crops generally need to have more carbon dioxide added when temperatures are low than when temperatures are high.

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(2)

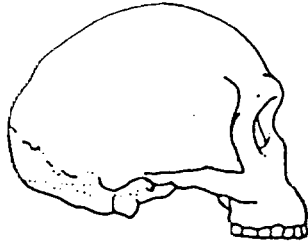
(Total 15 marks)

Now turn to the Synoptic Section on page 12

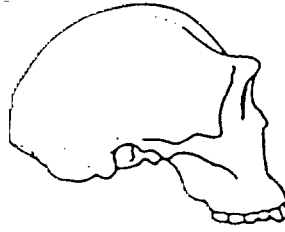
Section H: Biology (Human)

Answer ALL THREE questions in this section.

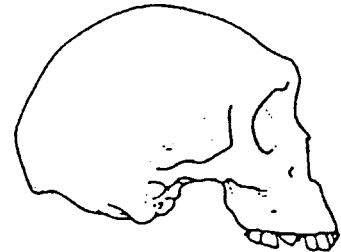
H1. The diagrams A, B and C below show three reconstructed fossil skulls of the genus *Homo*.



Skull A



Skull B



Skull C

(a) Arrange the letters in order with the earliest skull first and the most modern skull last.

..... (1)

(b) Give *three* features shown by these skulls which support your answer to (a).

1

.....

2

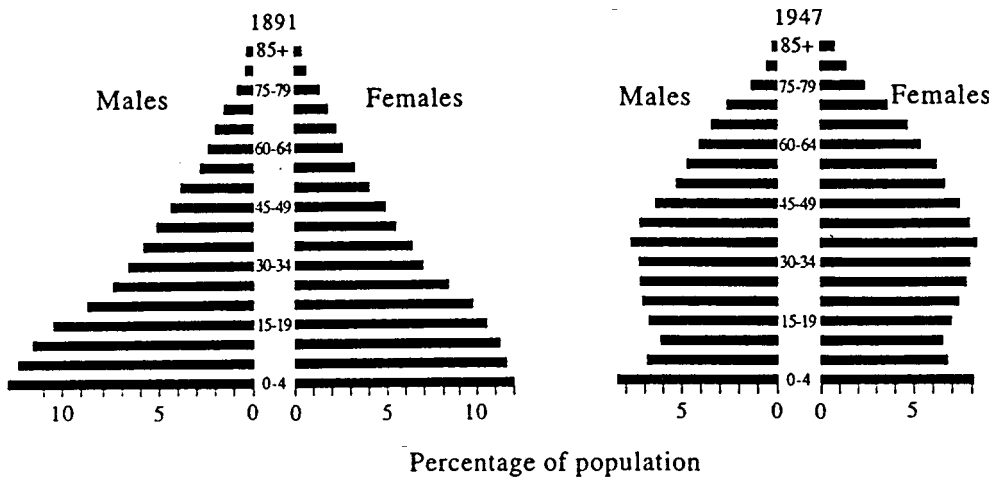
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3

..... (3)

(Total 4 marks)

H2. The diagrams below show the population pyramids for Great Britain for the years 1891 and 1947.



(a) State which of these pyramids is most likely to indicate a rapidly increasing population. Give a reason for your answer.

Pyramid

Reason

(2)

(b) Suggest why there are differences between the populations aged 30 and above in 1891 and in 1947.

.....

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(2)

(Total 4 marks)

H3. Haemoglobin in mammals is made up of four polypeptide chains, two identical α chains and two identical β chains. The sequence of amino acids in these chains has been determined for a number of different mammals.

Table 1 below shows a sequence of fifteen amino acids in an α chain from four different primates: a chimpanzee, a human, a gorilla and an orang-utan.

Table 1

| Primate | Amino acid sequence |
|------------|-------------------------------|
| Chimpanzee | K A A W G K V G A H A G E Y G |
| Human | K A A W G K V G A H A G D Y G |
| Gorilla | K A A W G K V G A H A G E Y G |
| Orang-utan | K T A W G K V G A H A G D Y G |

Key A = alanine D = asparagine E = glutamic acid G = glycine H = histidine
 K = lysine T = threonine V = valine W = tryptophan Y = tyrosine

(a) What differences are there between the amino acid sequence for the orang-utan and for the chimpanzee?

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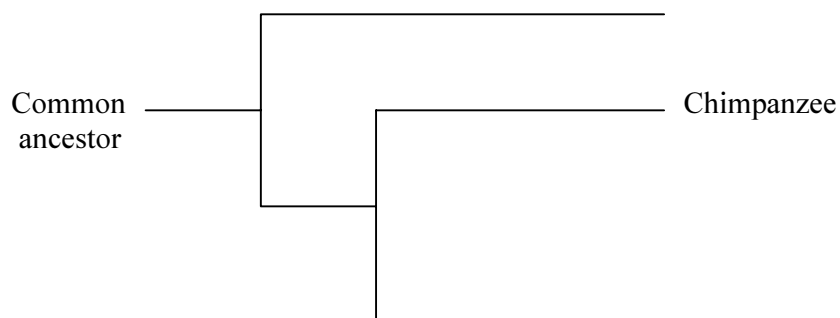
 (1)

(b) Name ONE OTHER pair of primates in the table in which there is a difference in the amino acid sequence.

.....
 (1)

(c) Comparisons of amino acid sequences have been used to determine evolutionary (phylogenetic) relationships in the primates.

Using evidence given in Table 1, complete the evolutionary tree diagram below to show the possible evolutionary relationship between chimpanzees, gorillas, humans and orang-utans.



(3)

(d) Give TWO ways in which the data in Table 1 support your suggested evolutionary relationship.

1

.....

2

.....

(2)

(e) When human blood serum is injected into a rabbit, the rabbit produces antibodies against human serum proteins. Precipitation occurs when blood serum from humans and other mammals is mixed with rabbit serum containing these antibodies,

Table 2 below shows the percentage precipitation when this rabbit serum is mixed with serum from a human, a gibbon, a spider monkey and a hedgehog.

Table 2

| Mammal | Percentage precipitation |
|---------------|--------------------------|
| Human | 100 |
| Gibbon | 79 |
| Spider monkey | 58 |
| Hedgehog | 17 |

What do these data suggest about the phylogenetic relationships of the four mammals in Table 2?

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(2)

(f) Explain why, in this procedure, these differences in percentage precipitation occur.

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(3)

(g) Describe how fossils can be used to provide evidence for human evolution.

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(3)

(h) Give ONE disadvantage of the use of fossils in providing evidence for human evolution.

.....
.....

(1)

(Total 16 marks)

Now turn to the Synoptic Section on page 12

Synoptic Section

Answer ALL FOUR questions in this section.

The questions in this section are designed to give you the opportunity to make connections between different areas of biology and to use skills and ideas developed throughout the course in new contexts. You should include in your answers any relevant information from the whole of your course.

4. The table below shows mean values for primary productivity for four ecosystems: temperate deciduous forest, tropical forest, temperate grassland, and intensively cultivated land in a temperate region.

| Ecosystem | Primary productivity / $\text{kJ m}^{-2} \text{yr}^{-1}$ |
|--|--|
| Temperate deciduous forest | 26 000 |
| Tropical forest | 40 000 |
| Temperate grassland | 15 000 |
| Intensively cultivated land in a temperate region. | 30 000 |

- (a) Suggest TWO reasons to account for the higher primary productivity of a tropical forest compared with a temperate forest.

- 1
-
- 2
-

(2)

- (b) Suggest explanations for the difference in primary productivity between temperate grassland and intensively cultivated land.

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.....
.....

(3)

- (c) Describe how you would estimate the fresh biomass of the producers in a grassland ecosystem.

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(4)

- (d) Suggest why productivity of an ecosystem is measured in units of energy rather than units of biomass.

.....
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.....
.....

(2)

(Total 11 marks)

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

Evolutionary change develops when a mutation occurs and survives the selective process (that is, when it is found to be either neutral or advantageous). For example, a GCT codon might mutate to GAT and we would obtain leucine instead of arginine in the protein.

In about 20% of all mutations, because of the redundancy (degeneracy) of the code, a mutation might have no effect on protein structure. Thus a mutation from GCT to GCA would affect only the DNA and might well have no functional effects – no matter what the third base in the GC codon, we always obtain arginine in the protein.

The evolutionary process, then, involves a change (mutation) in the DNA which is incorporated into the ongoing gene pool of the evolving species and which can be reflected by a corresponding change in the amino acid sequence of the particular protein coded for by that gene.

We might state as a basic rule that such a process will have to produce divergence when any two populations become isolated from one another, as the relative rarity of mutations and the finite size of populations make it statistically improbable that identical changes will be available for natural selection to incorporate into the gene pools.

Adapted from V Sarich: A molecular approach to the problem of human origins (1971)

(a) Explain what is meant by each of the following terms.

(i) A GCT codon (paragraph 1)

.....

 (1)

(ii) Redundancy (degeneracy) (paragraph 2)

.....

 (1)

(iii) Gene pool (paragraph 3)

.....

 (1)

(iv) Natural selection (paragraph 4)

.....

 (1)

(b) Suggest *two* ways in which ‘mutation from GCT to GCA’ (paragraph 2) might arise.

- 1
 -
 - 2
 -
- (2)**

(c) Explain why such a mutation ‘might well have no functional effects’ (paragraph 2).

-
 -
 -
 -
 -
 -
- (3)**

(d) State *two* ways in which ‘populations become isolated from one another’ (paragraph 4).

- 1
 -
 - 2
 -
- (2)**

(e) Outline the possible consequences of the ‘divergence’ (paragraph 4) that may result from such isolation.

-
 -
 -
 -
 -
 -
- (3)**

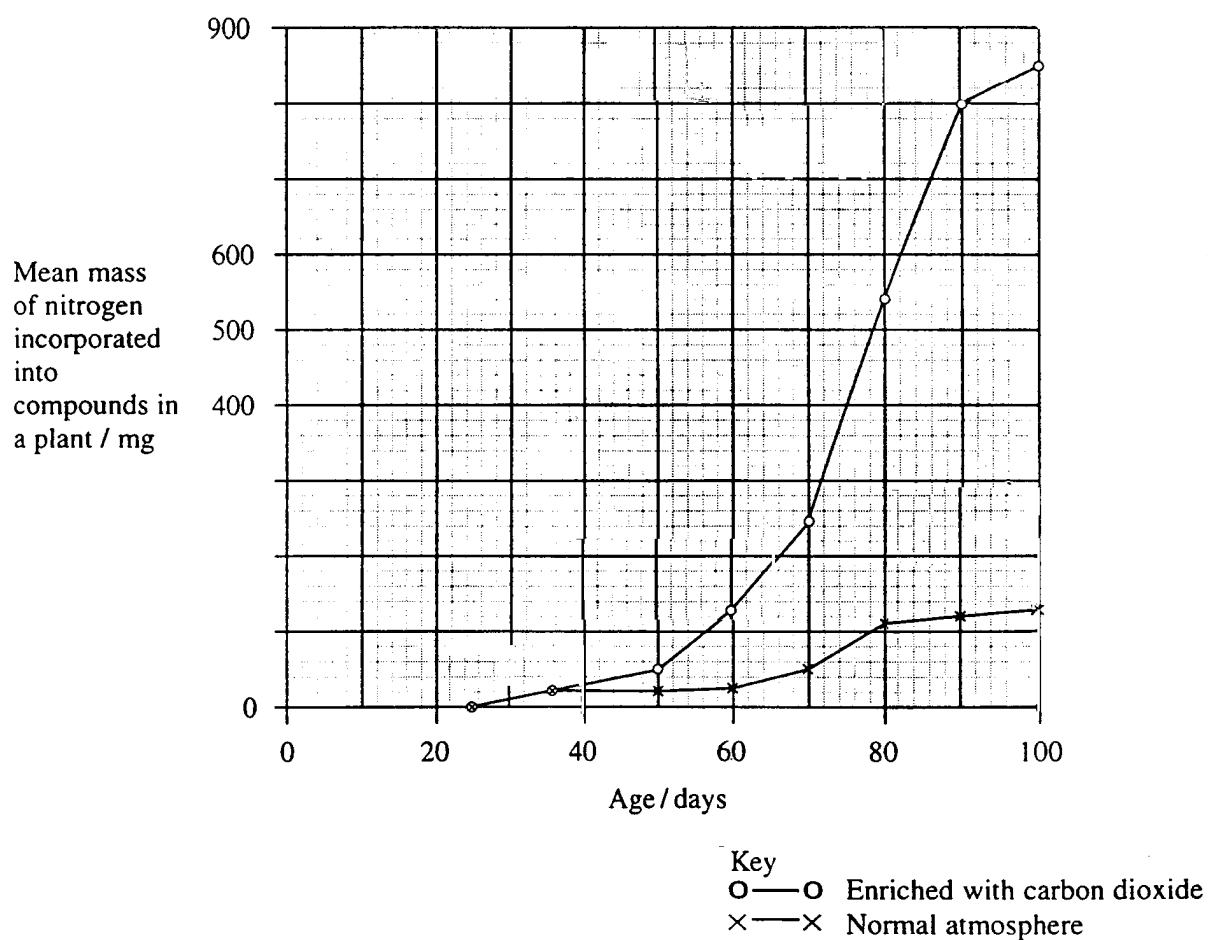
(Total 14 marks)

6. Some soyabean seedlings were grown in an atmosphere enriched with carbon dioxide.

An experiment was carried out to compare the uptake of nitrogen by these seedlings with that of seedlings grown in a normal atmosphere (control plants). Soyabeans belong to the Papilionaceae (legumes) and all the experimental plants had root nodules containing *Rhizobium*.

At the beginning of the experiment, the seedlings were 25 days old. The total amount of nitrogen incorporated into compounds in the plants was then measured at intervals until the plants were 100 days old.

The results of the experiment are shown in the graph below.



- (a) Of the nitrogen incorporated into compounds in the control plants, 75% was taken up from the soil. State the form in which this nitrogen was taken up by the plants.

.....
 (1)

(b) Explain how the control plants obtained the remaining 25% of their nitrogen.

.....
.....
.....
.....

(2)

(c) Compare the effect of the atmosphere enriched with carbon dioxide with that of the normal atmosphere on the mass of nitrogen incorporated into the seedlings.

.....
.....
.....
.....
.....
.....

(3)

(d) Suggest *one* reason for any differences you observe.

.....
.....

(1)

(e) A possible application of gene technology would be to incorporate genes for nitrogen fixation into cereal plants.

Suggest possible benefits of such an application.

.....
.....
.....
.....

(2)

(Total 9 marks)

6106/02

Edexcel GCE

Biology Biology (Human)

Unit Test 6 Paper 02 W2

Advanced
Specimen Paper

Time: 1 hour 20 minutes

Materials required for the examination

Nil

Items included with these question papers

Nil

Instructions to Candidates

In the boxes on the Answer Book provided, write the name of the Examining Body (Edexcel), your Centre Number, Candidate Number, the Subject Title, the Paper Reference, your surname, other names and signature.

The Paper Reference is shown towards the top left-hand corner of the page.

You must answer Question 1 and *either* Question 2B: (Biology) *or* Question 3H: Biology (Human)).

Show all the steps in any calculations and state the units. Calculators may be used.

Include diagrams in your answers where these are helpful.

Additional Answer Sheets may be used.

Information for Candidates

The marks for individual questions and the parts of questions are shown in round brackets: e.g. (2).

You must answer 2 questions in this question paper. There are no blank pages.

The total mark for this paper is 32.

Advice to Candidates

You must ensure that your answers to parts of questions are clearly numbered.

You will be assessed on your ability to organise and present information, ideas, descriptions and arguments clearly and logically, taking account of your use of grammar, punctuation and spelling.

You must answer Question 1 and EITHER Question 2B OR Question 3H

1. The diagram below shows some limpets. Limpets are cone-shaped molluscs which are found attached to rocks on many seashores.



Some students carried out an investigation to compare the shape of limpets on a sheltered shore with their shape on a shore exposed to the action of waves. They measured the height (H) and length (L) of 15 limpets on each shore. They then used the ratio of height to length to describe the overall shape of the limpets.

An extract from their field records is shown below.

| | | | | | | | | | |
|---|------|----------------|------|------|------|------|------|----------------------------------|--|
| 20/6/94 | | | | | | | | <i>Patella vulgata</i> | |
| <u>SHELTERED SHORE</u> - 15 LIMPETS (measurement in cm) | | | | | | | | 2.7 4.3 | |
| HEIGHT | 2.1 | 2.4 | 2.6 | 2.5 | 2.4 | 2.7 | 2.1 | | |
| LENGTH | 3.6 | 4.2 | 4.7 | 3.9 | 3.7 | 4.5 | 3.7 | | |
| RATIO H/L | 0.58 | 0.57 | 0.55 | 0.64 | 0.65 | 0.60 | 0.57 | | |
| HEIGHT | 3.0 | 2.9 | 2.9 | 2.5 | 2.8 | 2.9 | 3.1 | 2.6 | |
| LENGTH | 5.2 | 4.9 | 5.1 | 4.6 | 4.8 | 5.0 | 5.3 | 4.6 | |
| RATIO H/L | 0.58 | 0.59 | 0.57 | 0.54 | 0.58 | 0.58 | 0.58 | 0.56 | |
| <u>EXPOSED SHORE</u> - (15 LIMPETS measurement in cm) | | | | | | | | | |
| HEIGHT | 1.7 | 1.8 | 1.3 | 2.2 | 1.9 | 2.0 | 1.6 | | |
| LENGTH | 3.1 | 3.4 | 2.9 | 4.2 | 4.8 | 3.8 | 2.7 | | |
| RATIO H/L | 0.55 | 0.53 | 0.45 | 0.52 | 0.39 | 0.53 | 0.59 | | |
| HEIGHT | 1.9 | 2.0 | 1.7 | 2.2 | 1.9 | 1.2 | 1.7 | 1.9 | |
| LENGTH | 3.5 | 4.1 | 3.6 | 4.3 | 3.7 | 2.8 | 3.3 | 4.0 | |
| RATIO H/L | 0.54 | 0.49 | 0.47 | 0.51 | 0.51 | 0.43 | 0.51 | 0.48 | |

- (a) Prepare a table and organise the data in a suitable way so that the range of shapes of limpets on the two shores can be compared. **(4)**
- (b) Use the data in your table to present the information in a suitable graphical form. **(4)**
- (c) Name the statistical test you would use to analyse your data. **(1)**
- (d) What conclusions can you draw from this investigation? **(2)**

(Total 11 marks)

Answer EITHER Question 2B (Biology) OR Question 3H (Biology (Human))**2B. Biology**

Many fruits and seeds contain germination inhibitors which delay germination until the inhibitors have been washed away by rain or become inactivated. In tomatoes, the inhibitors delay germination until the fleshy tomato fruit has rotted away releasing the seeds.

It has been suggested that, in tomatoes, the inhibitor of seed germination is present in the fleshy tissues of the fruit rather than in the seed coats.

Plan an investigation, which you could personally carry out, to test this hypothesis. Your answer should give details under the following headings.

- (a) Plan of the investigation to be carried out. (9)
- (b) Recording of raw data measurements, presentation of results and methods of data analysis. (7)
- (c) Limitations of your method, and an indication of further work which could be undertaken. (5)

(Total 21 marks)

3H. Biology (Human)

Synaptic transmissions can be affected by various drugs such as caffeine. It has been suggested that caffeine acts as a stimulant and so reduces the time taken to respond to a visual stimulus.

Plan an investigation, which you could personally carry out, to test this hypothesis. Your answer should give details under the following headings.

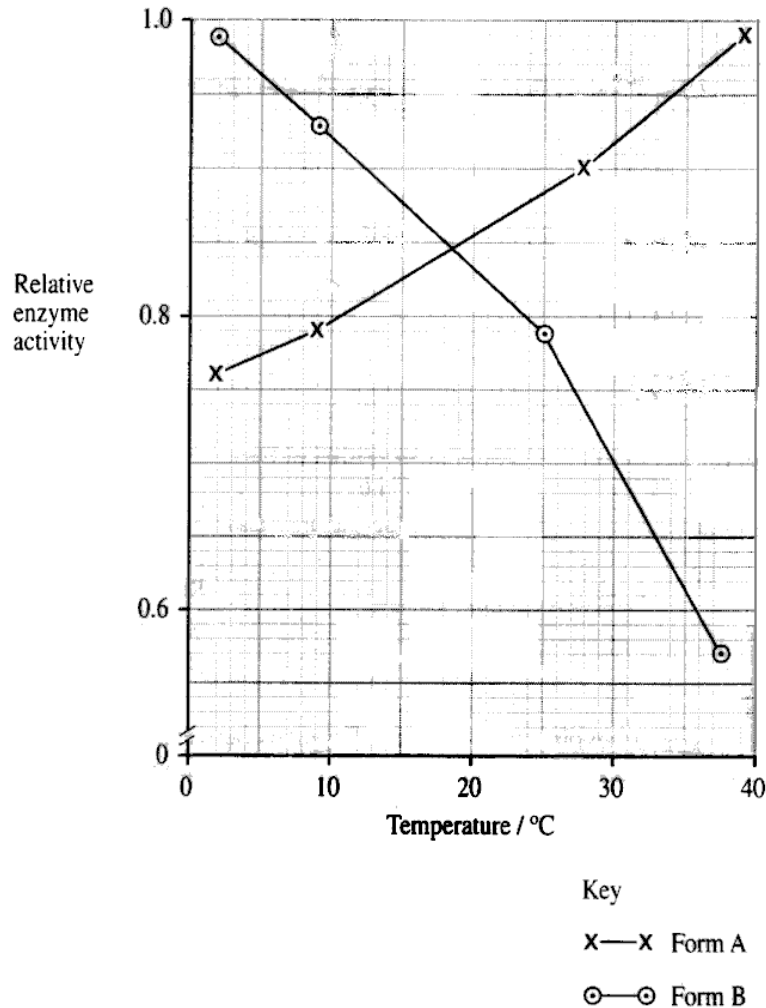
- (a) Plan of the investigation to be carried out. (9)
- (b) Recording of raw data measurements, presentation of results and methods of data analysis. (7)
- (c) Limitations of your method, and an indication of further work which could be undertaken. (5)

(Total 21 marks)

END

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1. North American populations of catfish, *Catostomus clarki*, produce two different forms of a particular enzyme, A and B. The graph below shows how the activity of each form of the enzyme varies with temperature. Enzyme activity is plotted as a proportion of its maximum activity, which is given the arbitrary value of 1.0.



Adapted from Edwards, Evolution in modern biology (1977)

- (a) Describe the differences in activity between the two forms of the enzyme.

.....

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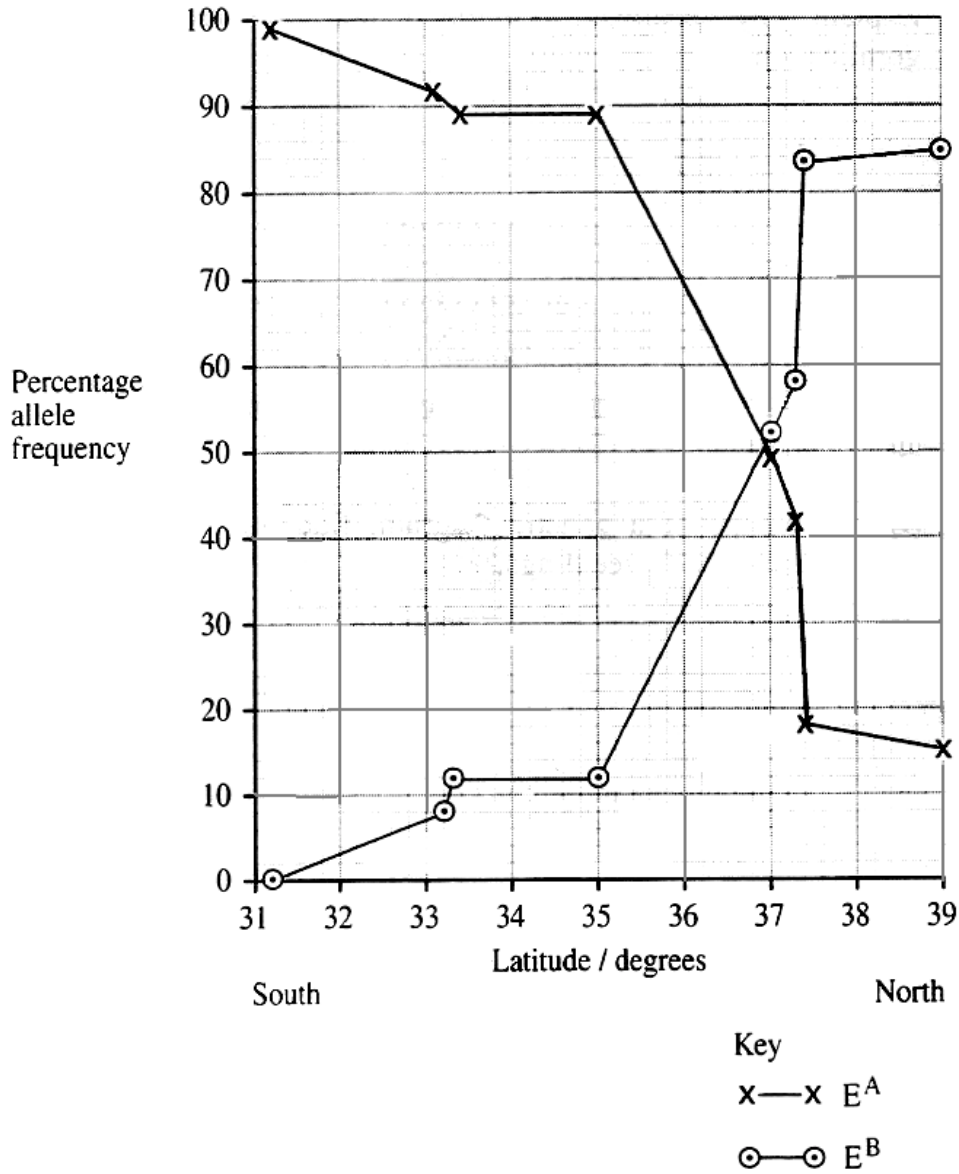
.....

.....

.....

(3)

- (b) Production of the enzyme is controlled by a single gene, E. An allele E^A codes for form A of the enzyme, and a different allele E^B codes for form B. The graph below shows the frequency of each allele in catfish populations between the southern and northern ends of the catfish's range. The southern end has a warm climate and the northern end a cold climate.



Suggest the process by which gene E came to have two different alleles.

.....

.....

(1)

- (c) Describe and suggest an explanation for the distribution of the alleles between the southern and northern ends of the catfish's range.

.....

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(4)

(Total 8 marks)

- 2. Read the passage below about the effect of chilli peppers on the body, and then use the information in the passage and your own knowledge to answer the questions which follow.

Chilli peppers (*Capsicum frutescens*) contain a substance called capsaicin, which produces the painfully hot sensation that we receive when eating foods seasoned with chilli. It has been known for some time that capsaicin produces its effect on a particular type of sensory neurone. These neurones respond to painful stimuli such as high temperatures, or to inflammation of tissues. Exposure of the endings of these neurones to capsaicin allows calcium ions (Ca^{2+}) and sodium ions (Na^+) to flood into the neurone. This initiates an action potential that is carried along the neurone into the spinal cord and then to the brain, where it is interpreted as pain.

It was thought that the sensory neurones probably contain a protein in their cell surface membranes that acts as a receptor for capsaicin. This protein could work in a similar way to the receptor for acetylcholine, which is found on the postsynaptic membrane at many synapses in the body. A group of researchers has recently identified the length of DNA which codes for this capsaicin receptor protein.

The researchers extracted mRNA of many different lengths from cells taken from dorsal root ganglia. The next step was to identify which of these lengths coded for the capsaicin protein. They mixed their mRNA samples with DNA nucleotides, and added an enzyme which made complementary lengths of DNA, called cDNA. They introduced samples of this cDNA into some cultured human cells, and allowed the cells to express the cDNA. They then exposed the cells to capsaicin. By identifying the cells that allowed calcium ions to flow into them when in the presence of capsaicin, the researchers were able to identify which of the many different lengths of cDNA coded for the capsaicin receptor protein. Once the cDNA had been identified, the amino acid sequence of the receptor protein could be worked out.

The researchers produced a clone of cells containing this cDNA, which had the capsaicin receptor in their cell surface membranes. They found that the receptor responded not only to capsaicin but also to high temperatures, which we perceive as painfully hot. They also found that, if the cells were exposed to capsaicin for a long period of time, they became less sensitive not only to capsaicin but also to high temperatures.

- (a) Explain how capsaicin initiates an action potential in a sensory neurone (paragraph 1).

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.....

(3)

- (b) Suggest why the researchers chose to use cells from dorsal root ganglia when they extracted mRNA (paragraph 3).

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.....
.....

(2)

- (c) Suggest why the researchers decided to try to identify the protein by extracting mRNA, rather than DNA, from these cells (paragraph 3).

.....
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.....
.....

(2)

- (d) Explain what is meant by DNA nucleotides (paragraph 3).

.....
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.....
.....

(2)

- (e) Name the enzyme that would be added to the mRNA and DNA nucleotides to make the cDNA (paragraph 3).

.....
.....

(1)

- (f) Explain how the amino acid sequence of the capsaicin receptor could be worked out once the cDNA which coded for it was identified (paragraph 3).

.....

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(3)

- (g) Capsaicin is often used to reduce pain in inflammatory conditions such as arthritis. Using the information in the passage, suggest how application of capsaicin to a painful joint might reduce the sensation of pain.

.....

.....

.....

.....

(2)

(Total 15 marks)

Write an essay on ONE of the following topics.

For Biology you should choose EITHER Question 3 OR Question 4B.

For Biology (Human) you should choose EITHER Question 3 OR Question 5H.

- 3.** The roles of water in the lives of organisms (15 marks)
- 4B.** The roles of pigments in living organisms (15 marks)
- 5H.** Evolution within the genus *Homo* (15 marks)

Write your essay in a separate answer book. Complete all of the details on the front cover of the answer book and fasten it loosely but securely behind this booklet.

Marks will be awarded for scientific content, coverage of the topic, and the quality of written communication. You may include diagrams if you wish, but make sure that they are relevant to your essay and add extra information to it.

END

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Mark schemes

Mark schemes

Advanced Subsidiary and
Advanced GCE

Biology
Biology (Human)

GENERAL MARKING POINTS

- ; indicates separate marking points
- / indicates alternative marking points
- // indicates a different approach to same marking point
- eq means allow any correct equivalent points (acceptable alternatives are discussed at the Examiners' coordination meeting)

Except for the essay questions in Unit 6 Paper 03 Synoptic Paper, no marks are awarded specifically for quality of language in the written papers. Use of English should however be taken into account as follows:

- the spelling of technical terms must be sufficiently correct for the answer to be unambiguous
- candidates must make their meaning clear to the examiner to gain the mark
- a correct statement that is contradicted by an incorrect statement in the answer to the same part of a question gains no mark

6101 UNIT 1 MARK SCHEME

- Marks**
- 1** (a) A Plasma membrane / cell membrane / cell surface membrane ;
B Centriole(s) / microtubule(s) / centrosome ;
C Golgi apparatus / Golgi body / smooth ER ;
D Rough ER / ribosome ;
- (4 marks)**
- (b) (Accept measurement between 11 and 12 mm)
 $11 \div 12\ 000$; OR $12 \div 12\ 000$;
 $= 0.92$; $= 1.0$
- (2 marks)**
- (Total 6 marks)**
-

- 2** (a) A Glycerol / propan – 1, 2, 3 – triol ;
B Fatty acid (s) / fatty acid chain ;
- (2 marks)**
- (b) Triglyceride ;
- (1 mark)**
- (c) Condensation / esterification ;
- (1 mark)**
- (d) Energy store or source / insulation / waterproofing / production of metabolic water / buoyancy / protection ;
- (1 mark)**
- (e) Insoluble / non-polar / high energy value / poor heat conductor / low density / less dense than water (points in (e) need to be correctly linked to the answer given in (d)) ;
- (1 mark)**
- (Total 6 marks)**
-

3

| Statement | Starch | Glycogen | Cellulose |
|------------------------------|--------|----------|-----------|
| Polymer of -glucose | ✓ | ✓ | X ; |
| Glycosidic bonds present | ✓ | ✓ | ✓ ; |
| Unbranched chains only | X | X | ✓ ; |
| Energy store in animal cells | X | ✓ | X ; |

(Total 4 marks)

4 (a) Diffusion of water molecules ;
Through a partially permeable membrane ;
From a region of high concentration of water molecules to a region of lower concentration of water molecules/eq in terms of water potential ;
(3 marks)

(b) Means whereby polar molecules are transported across membranes ;
Molecules bind with transport proteins ;
Transport protein changes shape and moves molecule across membrane ;
No metabolic energy required ;
(3 marks)

(Total 6 marks)

5 (a) A = Flagellum ;
C = (Peptidoglycan) cell wall ;
D = (Circular) DNA / chromosome / nucleoid ;
(3 marks)

(b) B = location of enzymes associated with aerobic respiration ;
C = maintains shape / protection / etc ;
E = storage of carbohydrate / eq ;
(3 marks)

(Total 6 marks)

- 6 (a) (Lower) epidermis of leaf ;
Stomata allow gaseous exchange / eq ;
Protection from desiccation / eq ;
Allows penetration of light to photosynthetic mesophyll ;
(3 marks)
- (b) Correct size / magnification ;
Correct proportions ;
Minimum number of cells / both stomata and cells touching ;
Cell wall thickness appropriate ;
Accurate detail of cell contents in guard cell ;
(5 marks)
- (Total 8 marks)**
-

- 7 (a) Protein / polypeptide / eq ;
(1 mark)
- (b) RER has ribosomes ;
Site of protein synthesis ;
(2 marks)
- (c) Proteins / polypeptides / move to Golgi apparatus ;
Ref. to protein modification ;
Enclosed in membranes to form vesicles ;
So most activity in vesicles after 45 minutes ;
(3 marks)
- (d) Amino acids moving between sites / eq ;
Amino acids being broken down / metabolised ;
Proteins used in other parts of cells / eq ;
Proteins also synthesised in mitochondria / eq ;
(3 marks)
- (e) Exocytosis ;
Vesicles move to cell membrane ;
Vesicle fuses with cell mebrane ;
Contents released outside cell ;
(3 marks)
- (Total 11 marks)**
-

- 8 (a) To keep pH constant / enzymes are affected by pH ; **(1 mark)**
- (b) Rate increases as substrate concentration increases ;
Steady / constant / linear increase between 20 to 80* mmol dm⁻³ ;
Then begins to level off ;
(*accept any quoted figure in this range) **(3 marks)**
- (c) As substrate concentration increases, the number of collisions / number of enzyme – substrate complexes will increase ;
Therefore the rate will increase ;
Until all enzymes in use / limited number of active sites ;
Rate then remains constant / reaches a maximum / ref to V_{max} ; **(3 marks)**
- (d) Use equal volumes of hydrogen peroxide solution ;
And distilled / deionised water / buffer solution ;
(accept suggested volumes) **(2 marks)**
- (e) Use a water bath ;
Suggested range of temperatures (at least 3 stated) ;
Use same substrate concentration ;
Use same volume / depth of hydrogen peroxide ;
Allow substrate / enzyme to equilibrate before adding filter paper disc ;
Ref. to uniformity of discs ;
Use constant enzyme concentration ;
Repeat at each temperature ;
Plot a graph of rate of reaction against temperature ; **(4 marks)**
- (Total 13 marks)**
-

- 9**
- 1 Daughter cells have same number of chromosomes as parent cell / are genetically identical to parent cell ;
 - 2 Concerned with growth / repair / replacement of tissues / asexual reproduction ;
 - 3 Reference to cell cycle consisting of interphase, mitosis, cell division ;
 - 4 (During prophase) chromosomes condense / eq so each consists of a pair of chromatids joined by centromere ;
 - 5 Reference to centrioles / movement / position ;
 - 6 Formation of spindle by microtubules ;
 - 7 Disappearance of nucleus / nucleoli ;
 - 8 Breakdown of nuclear envelope ;
 - 9 (At metaphase) chromosomes attached to spindle fibres ;
 - 10 Lined up at equator of cell :
 - 11 (At anaphase) centromeres split / duplicate / separation of chromatids ;
 - 12 Daughter chromosomes / chromatids pulled to opposite poles of cell / (at telophase) chromosomes / chromatids reach poles of cell ;
 - 13 Formation of nuclear membrane / (daughter) nuclei formed ;
 - 14 Followed by cytokinesis (in animal cells) / or description ;
 - 15 Formation of a cell plate / eq in plant cells ;

(Maximum 10 marks)

(Total 10 marks)

6102 and 6112 UNIT 2 MARK SCHEME

Section 1: Structured questions

- | | | Marks |
|----------|---|------------------------|
| 1 | (a) Large surface area ; Thin lining ; (Partially) permeable (lining) ; Covered by film of moisture ; | (3 marks) |
| | (b) Contraction of diaphragm muscles lowers / flattens diaphragm ; Contraction of external intercostal muscles raises ribcage ; Volume of thorax / lungs increases thus intrapulmonic pressure falls / eq ; Ref. to control by medulla / eq ; | (3 marks) |
| | | (Total 6 marks) |
| <hr/> | | |
| 2 | (a) A = (Aortic) semilunar valve ; B = Bicuspid / mitral / valve / left atrioventricular valve ; | (2 marks) |
| | (b) Diastole / atrial systole ; Aortic / plumonary artery / semilunar valve(s) closed ; Atrioventricular / mitral / tricuspid valve(s) open ; | (3 marks) |
| | (c) X = prevents valve inverting ; Y = adjusts tension in valve / contracts to pull on valve ; | (2 marks) |
| | | (Total 7 marks) |
| <hr/> | | |
| 3 | (a) Percentage falling / fall of 35% ; Biggest drop in sixties / between 1951-1970 ; Some evidence of flattening / ref. to figures ; | (2 marks) |
| | (b) Lower percentage of men with low sperm counts at beginning ; Numbers increasing during the period / increased by 13% ; Both fall 1971-1980 ; Fall in percentage of men with high sperm counts is greater than rise in percentage of men with low sperm counts / converse ; Biggest rise in numbers in sixties / corresponds with drop in numbers of men with high sperm counts / fluctuations in numbers of men with low sperm counts ; After 1980 figures similar ; | (3 marks) |

(c) Large numbers do not reach fallopian tubes / site of fertilisation ;
Many sperm die ;
Ref. to conditions / pH in vagina ;
Enzymes needed for activation of sperm / ref. capacitation ;
Many sperm may be abnormal / reduced mobility ;
(2 marks)

(d) (i) Stimulated by FSH ;
Stimulates repair of the endometrium / lining of uterus ;
Inhibits FSH production ;
Stimulates LH production ;
Leads to ovulation ;
(3 marks)

(ii) In maternal blood / blood stream ;
When fat stores mobilised / broken down ;
Correct ref. to diffusion ;
Correct ref. to placenta ;
Uptake into fetal circulation / fetal blood ;
Into umbilical vein ;
(3 marks)

(Total 13 marks)

4 (a) Any value between 17.0 and 18.0% ;
(1 mark)

(b) $90 - 18 = 72$;
 $105 \times 72 \div 100$;
 75.6 cm^3 ;
(3 marks)

(c) Increased rate of respiration / or metabolic rate increase / e.q./ gives more heat energy / eq ;
Causing haemoglobin to release more oxygen / release oxygen faster / eq ;
(2 marks)

(d) Curve drawn to the left of the other two ;
Steeper ;
(2 marks)

(Total 8 marks)

Section B: Biology

Unit 2

B5(a) D ;
G ;
(2 marks)

(b) Petals / no petals ;
Sepals / no sepals ;
Fixed stamens / loose stamens / eq ;
Knob-like stigma / feathery stigma ;
Short filaments / long filaments ;
(2 marks)

(c) Any two from:
Dichogamy / male and female parts mature at different times ;
Protandry / eq ;
Pollen shed before stigma is mature ;

Any two from:
Dichogamy / male and female parts mature at different times ;
Protogyny / eq ;
Stigma withers / ripe before pollen shed ;

Paired marking points:
Structure of flower prevents pollen landing on stigma ;
Explanation of heterostyly ;

Ref. to dioecious plants ;
Self-pollination impossible ;

Self-incompatibility / sterility ;
No pollen germination ;
(2 marks)

(Total 6 marks)

B6

| Statement | Xylem vessels | Phloem sieve tubes |
|---|---------------|--------------------|
| Possess living contents | X | ✓ |
| Provide support | ✓ | X |
| Composed of cells fused together end to end | ✓ | ✓ |
| Walls contain lignin | ✓ | X |

(Total 4 marks)

- B7(a)** P = xylem ;
Q = spongy mesophyll ;
(2 marks)
- (b) Falls in Y / or Z / moves out of Y / or Z ;
Rises in X / moves into X ;
Credit for correct manipulation of figures ;
(2 marks)
- (c) Active transport of K⁺ ions into guard cell ;
Correct ref. to lowering of water potential / eq ;
Water enters guard cells by osmosis ;
Increase in turgidity / eq ;
Causes bending of guard cells / eq ;
(3 marks)
- (Total 7 marks)**
-

- B8(a)** Water loss / transpiration equals / is proportional to water uptake ;
(1 mark)
- (b) Cut stem under water ;
Assemble apparatus under water ;
Render apparatus water tight / air tight with vaseline / wax ;
(Run water through capillary to) eliminate air bubbles ;
Ensure leaves / eq are dry ;
Control of variables / one variable specified ;
Ref. to equilibration ;
(2 marks)
- (c) (Meniscus moves) 180 mm (in 30 minutes) ;
 $(180 \div 30) \times 0.8 / (180 \div 120) \times 3.2$;
 $4.8 \text{ mm}^3 \text{ min}^{-1}$;
(3 marks)
- (d) Moving air causes more water vapour to be lost from B than D / less from D than B / eq ;
More water (vapour) lost through stomata ;
More stomata on lower surface of leaves ;
Grease prevents water loss through / blocks these stomata / acts as a barrier ;
(3 marks)
- (Total 9 marks)**
-

- B9**
- 1 Lower / more variable concentrations of oxygen in water than in air / eq / ref. to solubility ;
 - 2 Very low / anaerobic conditions in mud / undisturbed water / eq ;
 - 3 Disturbance / photosynthesising plants increases oxygen levels ;
 - 4 In small invertebrates / eq surface area to volume ratio important for efficient diffusion / e.g. protozoa / coelenterates absorb oxygen all over surface exposed to water ;
 - 5 Flattened body shapes increase surface area to volume ratios / so planarians / leeches can absorb sufficient oxygen ;
 - 6 Gills provide larger surfaces for gas exchange in some aquatic insect larvae / named e.g.s such as caddis fly larvae ;
 - 7 Some depend on tracheae located at hind end of insect ;
 - 8 Ref. to breathing tubes and siphons in suitable e.g.s such as rat-tailed maggots / eq ;
 - 9 Problems of waterlogging overcome by the presence of hairs / eq ;
 - 10 Small insects depend on diffusion, larger ones often show ventilation movements ;
 - 11 Some take air down into the water / ref. to air bubbles / trapped air / description or reference to an example such as water beetle ;
 - 12 Ref. to molluscs as being typical of better aerated water ;
 - 13 Pulmonates need to come to surface for air / eq ;
 - 14 Possession of respiratory pigments aids absorption / retention of oxygen / respiratory pigments / haemoglobin has affinity for oxygen at low pps ;
 - 15 Found in *Tubifex* worms / midge larvae in still water / *Tubifex* worms also show ventilation movements / waving tails around to increase uptake of oxygen ;

(Total 10 marks)

Section H: Biology (Human)**Unit 2**

-
- H5(a)** A = secondary oocyte ;
 B = Graafian follicle ;
 C = primary oocyte / eq ;
(3 marks)
- (b) Mitosis ;
(1 mark)
- (c) FSH / eq ;
(1 mark)
- (Total 5 marks)**
-

- H6(a)** Caused by a reduction in the amount of organic material in bone tissue ;
 Due to lack of stress / inactivity in older people ;
 Deficiency of protein in diet ;
 Deficiency of Vitamin D, so Ca and P not absorbed ;
 Reduced secretion of oestrogen in post-menopausal women ;
(3 marks)
- (b) Wearing away of the cartilage at the joints ;
 Causes pain / eq ;
(2 marks)
- (Total 5 marks)**
-

H7

| Statement | Epithelium | | |
|---|------------|----------|---|
| | Squamous | Cuboidal | |
| Cells are bonded to a basement membrane | ✓ | ✓ | ; |
| Cells are wider than they are tall | ✓ | X | ; |
| Nuclei are flattened | ✓ | X | ; |
| All cells possess cilia | X | X | ; |

(Total 4 marks)

- H8(a)** Head of fetus is relatively twice size of that of new-born / is half of body while new born is quarter / 50% compared to 25% ;
(1 mark)
- (b) Early development of brain / sense organs in head ;
Rest of body / limbs grow more slowly ;
Since not needed for locomotion before birth / in uterus ;
(2 marks)
- (c) Head of 25 year old (relatively) smaller (than 6 year old) ;
Limbs of 25 year old (relatively) longer ;
Body / trunk of 25 year old (relatively) longer ;
Genitalia of 25 year old (relatively) larger ;
Shoulders of 25 year old (relatively) larger / wider ;
(3 marks)
- (d) Androgens / testosterone ;
Growth hormone / somatotrophin ;
Genetic inheritance ;
Thyroxine / corticosteroids ;
Supply of nutrients / food / diet ;
Effects of exercise ;
(2 marks)
- (e) Different parts of body / organs grow at different rates ;
Growth in height not always accompanied by growth in mass / growth in mass during growth spurts follows growth in height ;
People with same height may have different mass / people with same mass may be of different heights ;
Mass may be subject to temporary fluctuations / eq / obesity/ pregnancy / menstrual cycle which do not reflect any growth ;
Difficult to measure height in young babies ;
(4 marks)
- (Total 12 marks)**
-

- H9**
- 1 Skin colour related to heat radiation / loss from body / eq ;
 - 2 Ref. to nose shape e.g. narrow in low temperature / related to temperature of air entering / leaving lungs ;
 - 3 Low temperature, straight hair / high temperature coiled hair ;
 - 4 Related to heat loss from neck / head ;
 - 5 Ref. to high / low amount of subcutaneous fat / related to (thermal) insulation ;
 - 6 Low temperature, short and stocky / short limbs / eq // high temperature, tall and thin / long limbs / eq ;
 - 7 Related to surface area and degree of heat loss / correct ref. to surface area to volume ratio ;
 - 8 High temperature, behavioural adaptations e.g. sleep / shade ;
 - 9 Low temperature, reduced bradycardia (lower heart rate) ;
 - 10 Correct ref. to level of sweating / heat loss due to vaporisation ;
 - 11 Correct ref. to vasoconstriction / vasodilation ;
 - 12 Loose / no clothing in high temperature / pale / light clothing reflects heat / thick / many layers / eq of clothing in cold temperature ;
 - 13 Housing qualified e.g. thick walls for insulation / small windows reduce wind ;
 - 14 Increased food intake in low temperature / decrease in high / increased water intake in high temperature ;
 - 15 Use of fire in cold ;

(Total 10 marks)

6103 UNIT 3 Paper 03 MARK SCHEME

| | | Marks |
|----------|--|------------------------|
| 1 | (a) Holds on to gut wall / eq ; To prevent removal (from host) ; Ref. to peristalsis ; | (2 marks) |
| | (b) Ref. to parasitism ; (Host's) food absorbed through body wall / cuticle / eq ; Food digested by host / eq ; | (2 marks) |
| | (c) <i>Rhizopus</i> is a saprobiont / saprophyte / description / eq ; Digests own food / extracellular digestion / eq ; | (2 marks) |
| | | (Total 6 marks) |

- 2** (a) Loss of vegetation cover ;
Exposed soils dry out ;
Soil erosion ;
Soils blown over surrounding land ;
Salinisation ;
(3 marks)
- (b) More animals kept / increasing human population / restricted migration
due to national borders / falling rainfall has upset the balance / lower
levels of recovery by plants ;
(1 mark)
- (c) More water available for crops ;
Growing crops less suited to climate / cash crops ;
Increased irrigation ;
More vegetation so more grazing animals ;
Human migration into region ;
Population increase above carrying capacity ;
(2 marks)
- (d) Crop failure ;
Widespread famine ;
Loss of vegetation cover ;
Increased rate of desertification ;
(2 marks)
- (e) Increasing global temperatures ;
Shift in climate belts ;
Lower rainfall ;
(2 marks)
- (f) Planting trees / shelter belts ;
Agroforestry (trees and crops) ;
Building earth banks / bunds to stop water running off ;
Terrace sloping land ;
Cover soil with mulches / plastic to reduce evaporation ;
Grow drought resistant / salt tolerant crops ;
Use native species of animals which tend not to overgraze ;
(2 marks)
- (Total 12 marks)**
-

- 3 (a)** Burning fossil fuels in power stations / cars ;
Release of sulphur dioxide and nitrogen oxides ;
Release of ozone / hydrocarbons ;
React together to form acids dissolved in rain ;
Specific gas linked to a named acid / eq ;
(4 marks)
- (b) pH level stable at approx. 5.6-5.8 for more than 75 years ;
Decrease in pH only occurred since 1975 ;
Drop of more than one pH unit ;
Spread of industry ;
Burning more fossil fuels ;
Increased power generation / more power stations ;
Clearance of forests from the area ;
Not due to Industrial Revolution as changes too recent ;
(4 marks)
- (c) Other changes in water quality ;
Misidentification ;
Disturbance of the sediment by animals ;
In-wash of diatoms from streams ;
(1 mark)
- (d) Affects larger organisms, especially fish and amphibians ;
Affects gills of fish ;
Due to increased mucus production ;
Reduces viability of the fish and amphibian eggs / eq ;
(3 marks)
- (e) When aluminium concentration is at 0, the survivorship is nearly 100 with both treatments ;
For both treatments, as aluminium concentration increases survivorship of fry decreases ;
Greater survivorship at higher levels of aluminium with the higher calcium concentration ;
In high calcium and high aluminium, survivorship is greater at lower pH ;
In low calcium and high aluminium, survivorship is greater at pH 5.4 ;
(4 marks)
- (f) Aluminium comes from soil ;
Liming soil will neutralise run-off into the lake ;
Longer lasting effect ;
Liming water is short-term as more acidity drains into the lake from surrounding streams and slopes / eq ;
(2 marks)
- (g) Legislation / large combustion plant plants directive ;
Fitting flue gas desulphurisation filters to chimneys of power stations ;
Fitting catalytic converters to cars / emission standards on engines ;
(2 marks)

(Total 20 marks)

6104 UNIT 4 MARK SCHEME

Section 1

| | | Marks |
|----------|---|------------------------|
| 1 | (a) Glycolysis ; | (1 mark) |
| | (b) Cytoplasm / cytosol ; | (1 mark) |
| | (c) Active transport / ion pumps / phosphorylation of substrate / named example / in stage A / muscle contraction / movement / light-independent reaction / any named anabolic reaction e.g. protein synthesis / cell division / replication of DNA ; | (1 mark) |
| | (d) Stage A ; | (1 mark) |
| | (e) Stage D ; | (1 mark) |
| | | (Total 5 marks) |

| | | |
|----------|--|------------------------|
| 2 | (a) A = outer segment ; B = inner segment ; | (2 marks) |
| | (b) Periphery of retina / not in fovea / outside fovea ; | (1 mark) |
| | (c) Rhodopsin / visual purple ; | (1 mark) |
| | (d) Label to membrane disc ; | (1 mark) |
| | | (Total 5 marks) |

- 3 (a) (i) 0.17% ;
(ii) 28g ;
(iii) 52.8% ;
(iv) 0.0 g ;

(4 marks)

- (b) Correct reference to permeability to water / sodium / chloride ions ;
Chloride / sodium ions pumped out / moved out by active transport ;
As sodium / chloride ions only enter descending limb slowly ;
Surrounding tissue / medulla / interstitial spaces now more concentrated than / eq ;
Water drawn / passes out of Q / descending limb / d.c.t / collecting duct ;
By osmosis, filtrate becomes more concentrated ;

(4 marks)

(Total 8 marks)

- 4 (a) 30 $\mu\text{mol dm}^{-3}$;

(1 mark)

- (b) (i) Blood glucose concentration increases ;
Rapid / eq increase / correct use of figures / peak at 7.2 ;
Due to absorption from gut / enters blood stream / eq ;

(2 marks)

- (ii) Concentration decreases ;
Rapid / eq decrease / correct use of figures / lower at 120 mins than at 0 ;
Uptake by liver / muscle / adipose tissue / taken into cells ;

(2 marks)

- (c) Both increase up to 30 minutes / have highest value at 30 minutes ;
Then decrease ;
(Show similar pattern = 1 mark if first 2 points not made) ;
Rise in glucose stimulates insulin secretion ;
Positive feedback comment ;

(3 marks)

- (e) Low blood glucose stimulates release of glucagon ;
From α cells in Islets of Langerhans in pancreas ;
Glucagon stimulates / eq conversion of stored glycogen to glucose ;
In liver ;
Glucose released into blood circulation ;
Ref. to conversion of other energy stores if glycogen used up ;

(4 marks)

(Total 12 marks)

- 5**
1. Resting potential qualified / explained / described ;
 2. Excess Na^+ outside axon / eq excess K^+ inside ;
 3. Imbalance maintained by Na^+ / K^+ pump / eq ;
 4. Membrane becomes permeable to Na^+ / Na^+ diffuses in / Na^+ gates open ;
 5. Action potential / depolarisation / figures quoted ;
 6. Action potential independent of stimulus strength / correct ref. to threshold / eq ;
 7. Stimulus strength affects impulse frequency / eq ;
 8. Propagation by local currents / voltage gated channels ;
 9. Transient event / stated time ref. / less than 3-4 ms ;
 10. Unidirectional ;
 11. K^+ ions diffuse out ;
 12. Restoration of resting potential ;
 13. Refractory period / recovery period ;
 14. Ref. to hyperpolarisation ;
 15. Saltatory conduction in myelinated axon / or speed increased by increasing diameter of axon / eq ;

(Total 10 marks)

Unit 4 Option A: Microbiology and biotechnology

A1(a) A = RNA ;
B = bilipid layer / lipid / phospholipid / fatty acid chain / hydrophobic tail ;
C = glycoprotein / GP 120 / GP 41 ;

(3 marks)

(b) To produce DNA corresponding to the viral RNA / eq ;

(1 mark)

(c) DNA inserted into host cell's chromosomes / DNA / genome ;
Inactive / dormant / not stimulating cell to make new virus particles /
virus not replicating / eq ;

(2 marks)

(Total 6 marks)

A2 Crystal violet ;
Iodine ;
Ethanol / alcohol / eq ;
Safranin / carbol fuchsin / eq ;
Purple / eq ;

(Total 5 marks)

A3(a) To mix the contents (thoroughly) / eq ;

(1 mark)

(b) For aerobic respiration / to provide oxygen for respiration ;

(1 mark)

(c) Separates the liquid containing the penicillin / antibiotic ;
From the mycelium / hyphae / fungus / from *Penicillium* ;

(2 marks)

(d) To modify the penicillin / eq ;

(1 mark)

(e) Enzyme more stable / eq ;
Less enzyme needed ;
Enzyme re-usable ;
Does not contaminate the product / eq ;

(2 marks)

(Total 7 marks)

- A4(a)** Ref. to lag phase / no growth in numbers / eq ;
Period of adjustment ;
Synthesis of enzymes ;
(2 marks)
- (b) (i) Ref. to exponential / log growth or growth rate declines as glucose is used up ;
Cells use glucose (first) ;
(2 marks)
- (ii) Cells synthesising enzymes / lactase ;
For metabolising lactose / adapting to a new substrate ;
Ref. to diauxic growth / ref. to second lag phase ;
(2 marks)
- (iii) Second growth phase ;
Cells using lactose / second substrate / eq ;
Decreases as lactose / nutrients used up / enters stationary phase ;
(2 marks)
- (c) Counts viable cells ;
Each grows into a colony ;
(2 marks)
- (d) Numbers too great ;
So more accurate estimation ;
Pick the plate / dilution which is most suitable / eq ;
(2 marks)
- (Total 12 marks)**
-

Unit 4 Option B: Food science

B1 Salt / vinegar / acetic acid ;
Vitamin C / eq ;
Vitamin E / eq ;
Monosodium glutamate / salt / eq ;
Allergies / eq ;

(5 marks)

B2(a) $58.80 \div 1.55^2$;
24.47 / 24.5 ;

(2 marks)

(b) Person D ;

(1 mark)

(c) Any three from:
Gender ;
Age ;
Pregnancy ;
Lactation ;
General state of health ;
Lifestyle / level of activity ;

(3 marks)

(Total 6 marks)

B3(a) To kill pathogenic microorganisms / bacteria / eq ;

(1 mark)

(b) *Streptococcus* or *Lactococcus thermophilus* ;
Lactobacillus bulgaricus ;

(2 marks)

(c) Mixed strain / eq ;
More / faster rate of lactic acid production // ref. to synergism /
mutualistic / symbiotic relationship ;

(2 marks)

(d) Reduces the pH to 4.6 / 4.7 ;
Casein / milk protein coagulates at this pH ;
Yoghurt thickens ;
Gives characteristic taste / flavour ;

(2 marks)

(e) Inhibit / reduce the activity of the bacteria / or reduce / eq production of
lactic acid ;

(1 mark)

(Total 8 marks)

- B4(a)** (Loss = $730.0 - 620.5 = 109.5$ g)
($109.5 \div 730$) $\times 100$ / eq ;
Answer: 15% ; **(2 marks)**
- (b) Apples continue to respire ;
Using up carbohydrate / CO_2 released / lost ;
Water vapour lost ;
Loss of water occurs by transpiration / eq ;
Ref. to loss due to low humidity ; **(3 marks)**
- (c) Reduced loss / eq in mass if kept in paper bag ;
Use of figures / eg ref. to 7% loss ;
Less evaporation of water / less transpiration ; **(2 marks)**
- (d) Less loss in mass / less water loss ;
Less damage from handling / eq ;
Reduction in microbial activity / prevents entry of microorganisms ; **(2 marks)**
- (e) Reduced aerobic respiration ;
Reduces loss in mass ;
Helps to inhibit fungal attack / eq ;
Delays ripening / senescence ; **(2 marks)**
- (Total 11 marks)**
-

Unit 4 Option C: Human health and fitness

C1 High plasma cholesterol / hypertension / cigarette smoking ;
Coronary ;
Plaques / atheroma ;
Clots / thrombi ;
Oxygen / blood ;
Death / necrosis ;

(Total 6 marks)

C2(a) 35×1500 ;
 $= 52\,000 \text{ cm}^3 / 52.2 \text{ dm}^3$;

(2 marks)

(b) Number of breaths increases more rapidly with increase in exercise intensity ;
At high intensities lungs are almost fully inflated ;
No further inspiratory reserve volume ;

(3 marks)

(c) Two factors for 1 mark from:
Carbon dioxide concentration ;
Oxygen concentration / altitude ;
pH ;
Blood pressure ;
Hormones / adrenaline ;
Sleep / higher centres in brain ;

(1 mark)

(Total 6 marks)

C3(a) A = I band ;
B = A band ;

(2 marks)

(b) Myosin ;

(1 mark)

(c) Accuracy of myosin ;
Accuracy of actin ;

(2 marks)

(d) Increases size / cross sectional area of muscle ;
Increase in size of muscle fibres ;
Increase in number / size of myofibrils ;
Increase in amount of proteins / myosin ;

(3 marks)

(Total 6 marks)

C4(a) Progressive / steady increase from 0 to 800 units ;
Then increases less / ref. to change in rate of increase ;
Credit any manipulation of figures ;
(2 marks)

(b) Proportional / constant rate of increase from 0 to 400 units ;
Heart stretches more during diastole / contracts more during systole ;
Peaks / levels off at 500 to 600 units / peaks at 130 cm³ ;
Decreases at higher work levels / above 600 units ;
Ventricles empty less completely before they refill / during systole ;
(3 marks)

(c) Controlled by cardiovascular centre / medulla oblongata ;
Receives impulses from stretch receptors / baroreceptors ;
In vena cava / right atrium ;
Impulses from pH receptors / chemoreceptors ;
In aorta / aortic arch / carotid sinus ;
Impulses via sympathetic nervous system ;
Releases of noradrenaline / adrenaline ;
Noradrenaline / adrenaline causes increase in heart rate ;
Ref. to effect of high temperature / low pH / low pO₂ / more CO₂ ;
Stretching cardiac muscle leads to more powerful contraction ;
(5 marks)

(Total 10 marks)

6105 and 6115 UNIT 5 MARK SCHEME

Section B: Biology

Marks

B1 Fungi ;
 Animalia ;
 Plantae ;
 Protoctista ;

(Total 4 marks)

B2

| Effect | Auxins | Gibberellins | |
|---|--------|--------------|---|
| Promote cell elongation | ✓ | ✓ | ; |
| Promote root formation in cuttings and calluses | ✓ | X | ; |
| Promote fruit ripening | X | X | ; |
| Inhibit lateral bud development | ✓ | X | ; |
| Promote the breaking of dormancy in seeds | X | ✓ | ; |

(Total 5 marks)

- B3(a)** (i) Productivity rises ;
As more carbon dioxide available for photosynthesis ;
Ref. to increase less from 700 to 900 ppm CO₂ as some other factor could be limiting ;
(2 marks)
- (ii) Stays the same from 900 to 1100 ;
As another factor becomes limiting ;
Ref. to the drop at 1300 caused by photorespiration / excess CO₂ ;
(2 marks)
- (b) (i) Maximum increase = 3 units, percentage increase = 25% ;
(ii) Maximum increase = 12 units, percentage increase = 48% ;
(iii) Maximum increase = 20 units, percentage increase = 74% ;
(3 marks)
- (c) Increased light intensity increases productivity / photosynthesis ;
Light provides greater energy input / more reducing power for light-independent reactions / eq ;
(2 marks)
- (d) CO₂ is raw material for photosynthesis ;
Provides inorganic C for organic compounds ;
Combines with RUBP / is reduced ;
Forms carbohydrates / named compounds ;
Atmospheric levels are low / only 300 ppm / eq ;
So increase in levels will increase the rate of photosynthesis / productivity ;
(3 marks)
- (e) To control a variable / temperature affects the rate of the reactions in the light-independent stages ;
(1 mark)
- (f) At low temperatures CO₂ is less soluble / harder to absorb / eq ;
Adding CO₂ increases the concentration gradient making uptake easier / eq ;
At low temperatures more CO₂ could increase the rate of reaction ;
(2 marks)

(Total 15 marks)

H1(a) B, C, A **(1 mark)**

(b) Brow ridges (less prominent) ;
 Cranium (more domed) ;
 Face flatter ;
 Teeth (smaller / flatter) ;
 (Upper) jaw (shallower) / zygomatic arch ; **(3 marks)**

(Total 4 marks)

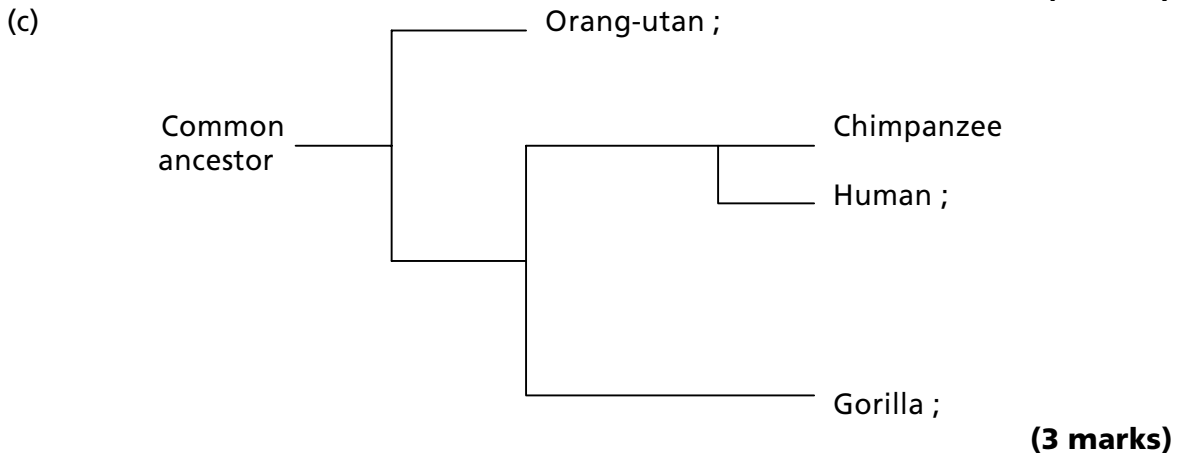
H2(a) Pyramid: 1891 ;
 Reason: ref. to widest base / highest % children / eq in the population
 (0-9 age range) ; **(2 marks)**

(b) 1891 females equal to males but in 1947 females greater than males ;
 1891 smaller % in each age range / stated age range / ref. to figures ;
 1891 gradual / eq decrease at each age range but 1947 increase in 35-39 ; **(2 marks)**

(Total 4 marks)

H3(a) Orang-utan has T instead of A and D instead of E / eq ; **(1 mark)**

(b) Chimpanzee and gorilla / gorilla and human / orang-utan and gorilla / orang-utan and human ; **(1 mark)**



(d) Human and chimpanzee have exactly same sequence, must be together ; Gorilla differs by one amino acid so more closely related to humans ; Orang-utan more differences / eq so not as close as gorilla / eq ; **(2 marks)**

(e) Gibbon closest to human ; Hedgehog most distantly related ; Spider monkey more distantly related than gibbon ; **(2 marks)**

(f) Any ref. to precipitate between antigen and antibody ; 100% with human serum because rabbit serum contains antibodies to all human serum proteins ; The more proteins in common the more / greater the precipitation ; The closer the phylogenetic relationship the greater the precipitation ; Hedgehog has very few serum proteins in common with humans ; **(3 marks)**

(g) Any ref. to dating ; Sequence of changes can be seen ; Skeleton / eq shows trend from quadrupedal to bipedal locomotion ; Changes in hands show evolution of dexterity ; Changes in jaws / teeth show change in diet ; Changes in skull / eq show evolution of brain ; **(3 marks)**

(h) Incomplete record / incomplete fossils / unreliable dating / displacement of fossils / fragmentary remains / rarity of fossils ; **(1 mark)**

(Total 16 marks)

- 4 (a) Higher / constant temperature / no / little seasonal change / eq ;
 Higher plant density ;
 Higher water availability / rainfall / eq ;
 Evergreen / eq plants / temperate trees have no leaves for part of year / eq ;
 More light (energy) / intensity / eq ;
(2 marks)
- (b) Crops all same type of plant / monoculture ;
 Use of crop rotation / fertilisers applied / eq ;
 Irrigation / eq ;
 Pests / diseases controlled / eq ;
 Crop varieties / plants selected for high yield ;
 Replanting after harvest ;
(3 marks)
- (c) Take several / random samples ;
 Use of quadrat of stated / eq size ;
 Remove / eq plants // count the number of plants ;
 Remove all consumers / remove soil ;
 Weigh to find (fresh) mass // weigh one x number of plants // multiply number of plants by value from table of biomass ;
 Multiply by area of grassland / eq ;
(4 marks)
- (d) Biomass includes inorganic component / eq ;
 Water content is variable / makes it less accurate / eq ;
 Productivity in energy units is true reflection of energy capture / eq ;
(2 marks)
- (Total 11 marks)**

Unit 5 Synoptic Section

- 5(a) (i) (DNA) triplet of (nitrogenous) bases consisting of guanine, cytosine, thymine // a group of bases / part of DNA which codes for an amino acid ;
(1 mark)
- (ii) More codons available than there are amino acids / eq ;
(1 mark)
- (iii) The total number of genes / alleles in a population ;
(1 mark)
- (iv) Means by which organisms best suited to prevailing environmental conditions survive / eq ;
(1 mark)
- (b) Any two from:
Substitution of (base) A for (base) T ;
Insertion of A ;
Deletion of T if next base is A ;
Inversion if next base is A ;
Ref. to mutation by ionising radiation / eq ;
Ref. to mutagenic chemicals / named e.g. ;
(2 marks)
- (c) Only the first two bases are necessary to code for the amino acid / arginine / ref. to degeneracy ;
All codons starting with GC code for the same amino acid / arginine ;
Not all changes in DNA result in a change in amino acid sequence in polypeptide // no change in protein structure ;
Therefore there is no change in protein function ;
This part of the DNA is not involved in protein synthesis ;
(3 marks)
- (d) Geographical isolation / ref. to a physical barrier ;
Prezygotic / pre-mating isolation (if given, other specific e.g.s do not score) ;
Behavioural isolation / ref. to example / courtship / eq ;
Ref. to polyploidy / postzygotic / post-mating ;
Seasonal isolation / mature at different seasons ;
Ecological isolation / ref. to different habitat preferences ;
Differences in genitalia in animals / different pollination mechanisms in plants ;
(2 marks)
- (e) Isolated populations become progressively / eq different from one another ;
Possibility of further changes / ref. to further mutation ;
Eventually two populations unable to interbreed successfully / eq ;
Even if barriers removed ;
Results in new species formed / results in speciation ;
(3 marks)

(Total 14 marks)

Unit 5 Synoptic Section

- 6 (a) Nitrate(s) (ions) / NO_3^- / ammonium (ions) / NH_4^+ ; **(1 mark)**
- (b) *Rhizobium* / or bacteria in root nodules able to use / fix (atmospheric) nitrogen ;
Reduced / converted to ammonia / ammonium ;
Combine with organic acids // to make amino acids // ref. to nitrogenase enzyme ; **(2 marks)**
- (c) No difference until day 36 / for first 10 / 11 days ;
Amount of nitrogen fixed is (then) greater in CO_2 enriched ;
In CO_2 enriched rate of increase greater / difference greater with time / accept converse for normal ;
In CO_2 enriched no plateau / levelling off / eq but in normal air levels off / figures quoted / 36-60 / remains at 20 mg ;
In CO_2 enriched smaller / eq increase after 90 days but in normal air not much increase after 80 days / eq ;
Credit correct attempt to work out %age increase / do something with the figures ; **(3 marks)**
- (d) More CO_2 so more photosynthesis / eq ; **(1 mark)**
- (e) Increase in yield / more crop ;
Cereals could grow on low nitrate / eq soils ;
Less / no need to use (inorganic) fertiliser ;
Environmental benefit qualified e.g. less nitrate ;
To be leached / less eutrophication / eq ; **(2 marks)**
- (Total 9 marks)**
-

- 7B**
- 1.U1 All energy-consuming processes need / use only one system / ATP ;
 - 2.U1 ATP mobile / able to move to any situation in cell requiring energy ;
 - 3.U1 Energy needed in cells for synthesis of macromolecules / eq ;
 - 4.U1 For active transport across cell surface membranes / eq ;
 - 5.U4 Metabolically active cells have high rates of aerobic respiration ;
 - 6.U4 Capable of synthesising large quantities of ATP from ADP and P_i ;
 - 7.U4 Hydrolysis of phosphoanhydride bonds yields relatively large amounts / eq of free energy / about 30 kJ / mol^{-1} ;
 - 8.U4 Once energy released on hydrolysis, energy for the re-synthesis of ATP comes from oxidation of carbohydrates / eq ;
 - 9.U4 Credit reference to some description of process ;
 - 10.U1 Liver cell has large numbers of mitochondria / metabolically active / eq ;
 - 11.U4 Ref. to carbohydrate metabolism ;
 - 12.U4 Protein synthesis / metabolism / deamination ;
 - 13.U5 Leaf epidermal cells photosynthetic / involved in synthesis of carbohydrate using light energy ;
 - 14.U5 Energy transferred from light to ATP requires the presence of chlorophyll / chloroplasts ;
 - 15.U5 ATP provides necessary energy for the reduction of CO_2 using NADPH in light-independent reactions ;
 - 16.U5 Details of cyclic photophosphorylation ;
 - 17.U5 Details of non-cyclic photophosphorylation ;
 - 18.U4 ATP also produced from respiration ;

(Total 12 marks)

- 7H**
- 1.U1 All energy-consuming processes need / use only one system / ATP ;
 - 2.U1 ATP mobile / able to move to any situation in cell requiring energy ;
 - 3.U1 Energy needed in cells for synthesis of macromolecules / eq ;
 - 4.U1 For active transport across cell surface membranes / eq ;
 - 5.U4 Metabolically active cells have high rates of aerobic respiration ;
 - 6.U4 Capable of synthesising large quantities of ATP from ADP and P_i ;
 - 7.U4 Hydrolysis of phosphoanhydride bonds yields relatively large amounts / eq of free energy / about 30 kJ / mol⁻¹;
 - 8.U4 Once energy released on hydrolysis, energy for the re-synthesis of ATP comes from oxidation of carbohydrates / eq ;
 - 9.U4 Credit reference to some description of process ;
 - 10.U1 Liver cell has large numbers of mitochondria / metabolically active / eq ;
 - 11.U4 Carbohydrate metabolism reference ;
 - 12.U4 Protein synthesis / metabolism / deamination ;
 - 13.U4 Role in nerve impulse transmission ;
 - 14.U2 Role in interaction between actin and myosin ;
 - 15.U2 Active transport of calcium ions into sarcoplasmic reticulum ;
 - 16.U5 Details of involvement of ATP in active transport ;
 - 17.U4 Membrane of neurone more permeable to K ions than Na ions, so K ions diffuse out faster than Na ions diffuse in / eq.;
 - 18.U1 Na/K pumps using ATP transport K ions in and Na ions out to maintain the resting potential of the neurone;
 - 19.U4 At synaptic knob, transmitter substance released when action potential reaches it / eq.;
 - 20.U4 Large numbers of mitochondria in the synaptic knobs of neurones provide energy for the reformation of the transmitter substance / acetylcholine which is stored in vesicles;

(Total 12 marks)

6106 UNIT 6 Paper 02 W2 MARK SCHEME

Marks

- 1** (a) Correct table of raw data (height, length, ratio) sheltered shore ;
Correct table of raw data (height, length, ratio) exposed shore ;
Mean ratio of sheltered (0.583) and mean of exposed (0.5) ;
Figures tallied into suitable size classes for each shore ;
Both size class tables correct ;
(4 marks)
- (b) Bar chart chosen as means of display ;
Correct axes and suitable scale ;
Chart shows simple means compared ;
Chart shows range of size classes for sheltered shore ;
Chart shows range of size classes for exposed shore ;
Both charts displayed for ease of comparison (e.g. with two charts
vertically matched or data plotted on same axes) ;
(4 marks)
- (c) t-test ;
(1 mark)
- (d) Limpets on sheltered shore are larger than those on exposed shore ;
Ref. to conclusions from ratio (e.g. if ratio is bigger then overall shape
must have changed / height must increase more than length / converse) ;
(2 marks)
- (Total 11 marks)**
-

- 2B(a)** Seeds from same species / variety ;
Ref. to optimum conditions for growth of seeds ;
Oxygen/ air / water ;
Suitable temperature (e.g. 15 to 20 °C) ;
Physical conditions for germination kept constant ;
Correct substrate for growth (soil / compost / cotton wool / eq) ;
Remove seeds from ripe tomato ;
Test for germination / count number germinated ;
Test for germination if tomato flesh present ;
Wash tomato flesh in running water ;
Use this in medium to test for germination / plant seeds with washed flesh ;
Plant seeds with seed coat extract / remove testa ;
Plant seeds without seed coat extract / with testa ;
Check for germination in thoroughly washed seeds ;
Germination defined / appearance of radicle / eq ;
Large suitable number of seeds in each test ;
Suitable replicates ;
Calculation of rate of germination % / eq ;
- (9 marks)**

- (b) Tabular format ;
Columns of washed and unwashed flesh ;
Column for dried seeds ;
Column for % germination / times for germination ;
Extra boxes for repeats ;
Bar chart / line graph ;
Correct axes ;
Calculation of means ;
Calculation of standard deviations ;
Use of t-test ;
Interpretation of t-test ;
- (7 marks)**

- (c) Tomatoes vary in ripeness ;
Initial treatment / conditions could vary ;
Assumes inhibitor is water soluble / would be removed by washing ;
Effects could be caused indirectly by a form of inactivation ;
Test effects on different strains ;
Test for seasonal variation ;
Test effects of extracts alone ;
Allow valid experiment not used in (a) ;
- (5 marks)**

(Total 21 marks)

- 2H(a)** Select volunteers (10 or more) ;
Control of sample (same age, same sex / eq) ;
Sources of caffeine controlled for 12 hours or more before test ;
Standard conditions for test ;
Lighting / instructions / distractions / eq (at least *two* named) ;
Detail of test / record time taken to switch off light signal / eq ;
Additional detail of test / use of computer generated light / electric timing necessary / eq ;
Volunteers tested with no caffeine ;
Test repeated (5 or more times) ;
Standard administration of caffeine, coffee / pro-plus tablets / cola / tea / cocoa / other suitable caffeine source / fixed dose ;
Standard time of dosage before testing ;
- (9 marks)**
- (b) Tabular format ;
Rows for raw data with no caffeine ;
Rows for raw data with caffeine ;
Calculation of means (accept from table) ;
Calculation of standard deviations ;
Use of t-test ;
Interpretation of t-test ;
Bar charts ;
Corrects axes suggested for bar chart ;
- (7 marks)**
- (c) Comment on variability of human subjects ;
Eyesight problems can affect result ;
Problem of learning / practice on sequence of measurements ;
Sensitivity of caffeine affected by pre-treatment (e.g. non coffee drinkers or decaffeinated coffee drinkers) ;
Need for accurate measurement of short reaction time ;
Test effects of different caffeine concentrations ;
Test for sex / age differences ;
Test for effect of caffeine on other reactions / learning ;
Any equivalent test ;
- (5 marks)**
- (Total 21 marks)**
-

UNIT 6 Paper 03 Synoptic Paper MARK SCHEME

Marks

- 1 (a)** Activity of form A increases steadily / eq / quote figures as temperature increases ;
Activity of form B decreases sharply / eq / quote figures as temperature increases ;
Credit for comment on decrease in activity of B being greater than increase in A ;
Activity is equal at about 18 °C ;
- (3 marks)**
- (b) (i) Mutation ;
- (1 mark)**
- (ii) E^A has a higher frequency than E^B in the south / converse ;
Frequency of E^A decreases northward / E^B increases northwards ;
So enzyme A more frequent in higher temperatures / enzyme B more frequent in lower temperatures ;
Correct suggestion re natural selection ;
- (4 marks)**
- (Total 8 marks)**
-

- 2** (a) Binds with receptor ;
Opens channel ;
Allows Ca²⁺ / Na⁺ to enter neurone ;
Depolarises membrane ;
(3 marks)
- (b) This is where the cell bodies of sensory neurones are ;
(Only) these neurones produce the capsaicin receptor ;
(2 marks)
- (c) Only some DNA is used to make mRNA / only some DNA is expressed ;
(So) fewer different types of mRNA in a cell than DNA ;
Easier to pick out required piece ;
(2 marks)
- (d) Monomers / components, which make up DNA molecule ;
(Molecules) containing phosphate, base and deoxyribose ;
(2 marks)
- (e) Reverse transcriptase ;
(1 mark)
- (f) Find nucleotide sequence of DNA ;
Three nucleotides / bases, code for one amino acid ;
Genetic code is known / can identify amino acid from bases ;
(3 marks)
- (g) Prolonged exposure to capsaicin reduces sensitivity (to high temperature) ;
Of neurones which respond to inflammation ;
Fewer action potentials along these neurones ;
(2 marks)
- (Total 15 marks)**
-

ESSAY MARK SCHEME

Outline Scheme For Marking Essay Questions 3, 4B and 5H

Scientific content

Above average

| | |
|----|-----------|
| 13 | Excellent |
| 11 | Good |

Essays in this category demonstrate a sound understanding of the topic, contain a significant amount of material relevant to two or more units of the specification, and suitable examples where appropriate.

Average

| | |
|---|------------------------|
| 9 | Slightly above average |
| 7 | Average |
| 5 | Slightly below average |

Essays in this category contain factually correct and relevant material. Some areas should show a progression from GCSE, particularly if a mark of 9 is awarded.

Below average

| | |
|---|------------------------|
| 3 | Some correct facts |
| 1 | Very few correct facts |
| 0 | No correct information |

Essays in this category contain few relevant facts. The material that has been included has little depth and barely reaches the standard expected at GCSE.

S = 13 marks

Balance

- 2 A balanced essay covering all the main areas outlined
Some discussion of each area covered with, suitable examples where applicable
Material all relevant to the topic
Few, if any, errors
- 1 Most of the main areas of the topic covered, but possibly one or two lacking
Some discussion of each of the areas chosen
Some irrelevance, either in the areas chosen or in the material within an area
Some errors
- 0 Very limited account, possibly only one aspect chosen
Material mostly irrelevant
Large number of errors

B = 2 marks

Coherence

- 2 Material logically presented, with little or no repetition
Essay has coherence, ideas are developed well; continuous prose used throughout
Essay has an introduction and a conclusion, summing up the main points
Technical terms have been used correctly
Spelling, punctuation and grammar are sound
- 1 Material is presented in an orderly way and some ideas developed
Continuous prose used throughout
The introduction and conclusion may be present, but brief
Technical terms are used and generally in the correct context
Spelling, punctuation and grammar are generally sound
- 0 Essay style not used
Material in note form or numbered points
Very poor standard of spelling, punctuation and grammar

C = 2 marks

Total max 15 marks

3 (essay)

Introduction to include reference to the physical properties of water – dipolar nature – water as a solvent – Solvent properties important in role of transport – together with cohesive properties -

Transport medium in animals – constituent of body fluids / blood – nature of substances transported – transport of cells in blood -

Transport medium in plants – for mineral ions – for products of photosynthesis – adhesive properties in transport in xylem -

Water as a cellular constituent – role in metabolic reactions – hydrolysis reactions – hydration -

Role of water as a reactant in photosynthesis – source of hydrogen ions -

Role of water in fertilisation – transport of gametes -

Role of water in support – turgidity of tissues in herbaceous plants – maintenance of shape – ref. to hydrostatic skeletons -

Water as a lubricant – synovial fluid – tears -

Water as a coolant – ref. to loss of heat on vaporisation – sweating and heat loss -

Water as a habitat – thermal properties of water – reference to freezing – surface tension -

Credit to be given in other areas where relevant -

(Scientific content 13 marks)

(Balance 2 marks)

(Coherence 2 marks)

(Total max 15 marks)

4B (essay) Introduction to include a definition of a pigment – some reference to the range of pigments in living organisms -

Respiratory pigments:

Haemoglobin – myoglobin - oxygen carriage -

Cytochromes and electron transport -

Credit references to other respiratory pigments -

Visual pigments:

Rhodopsin – occurrence in rods – vision at low light intensities -

Iodopsin – occurrence in cones – comment on colour vision – ref. to role of colour vision -

Plant pigments:

Chlorophylls and photosystems – roles in photosynthesis -

Other photosynthetic pigments – carotenes – credit other references -

Phytochromes – role in flowering – photoperiodic effects -

Role in photomorphogenesis / plant growth and development -

Flower pigments – anthocyanins / xanthophylls in flowers -

Role in pollination – flower markings –

Skin pigments:

Melanins in skin – functions -

Roles of pigments in camouflage – warning – courtship – mimicry –

(Scientific content 13 marks)

(Balance 2 marks)

(Coherence 2 marks)

(Total max 15 marks)

5H (essay) Introduction:
Humans as primates - some discussion of the place of primates in the Mammalia -

Evidence for evolution:
Comparative anatomy - fossils - geochronology - immunological studies - DNA base sequences -

Hominoid evolution:
Divergence of apes and hominids from a common ancestor - influences of climate - habitat -

Homo :
Main features of the genus - differences between species - changes in the size of skeleton - skull - brain development - bipedalism - evolution of the hand -

Expect some comment on the Palaeolithic and the Neolithic - from nomadic to settled communities -

(Scientific content 13 marks)

(Balance 2 marks)

(Coherence 2 marks)

(Total max 15 marks)

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