

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

A2 GCE

F214/01

BIOLOGY

**Communication, Homeostasis and
Energy**

MONDAY 17 JUNE 2013: Afternoon

**DURATION: 1 hour 15 minutes
plus your additional time allowance**

MODIFIED ENLARGED

| | | | |
|-------------------------------|--|------------------------------|--|
| Candidate forename | | Candidate surname | |
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| Centre number | | | | | | Candidate number | | | | |
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Candidates answer on the Question Paper.

OCR SUPPLIED MATERIALS:

None

OTHER MATERIALS REQUIRED:


**Electronic calculator
Ruler (cm/mm)**

READ INSTRUCTIONS OVERLEAF

INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes on the first page. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer ALL the questions.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Write your answer to each question in the space provided. If additional space is required, you should use the lined pages at the end of this booklet. The question number(s) must be clearly shown

INFORMATION FOR CANDIDATES

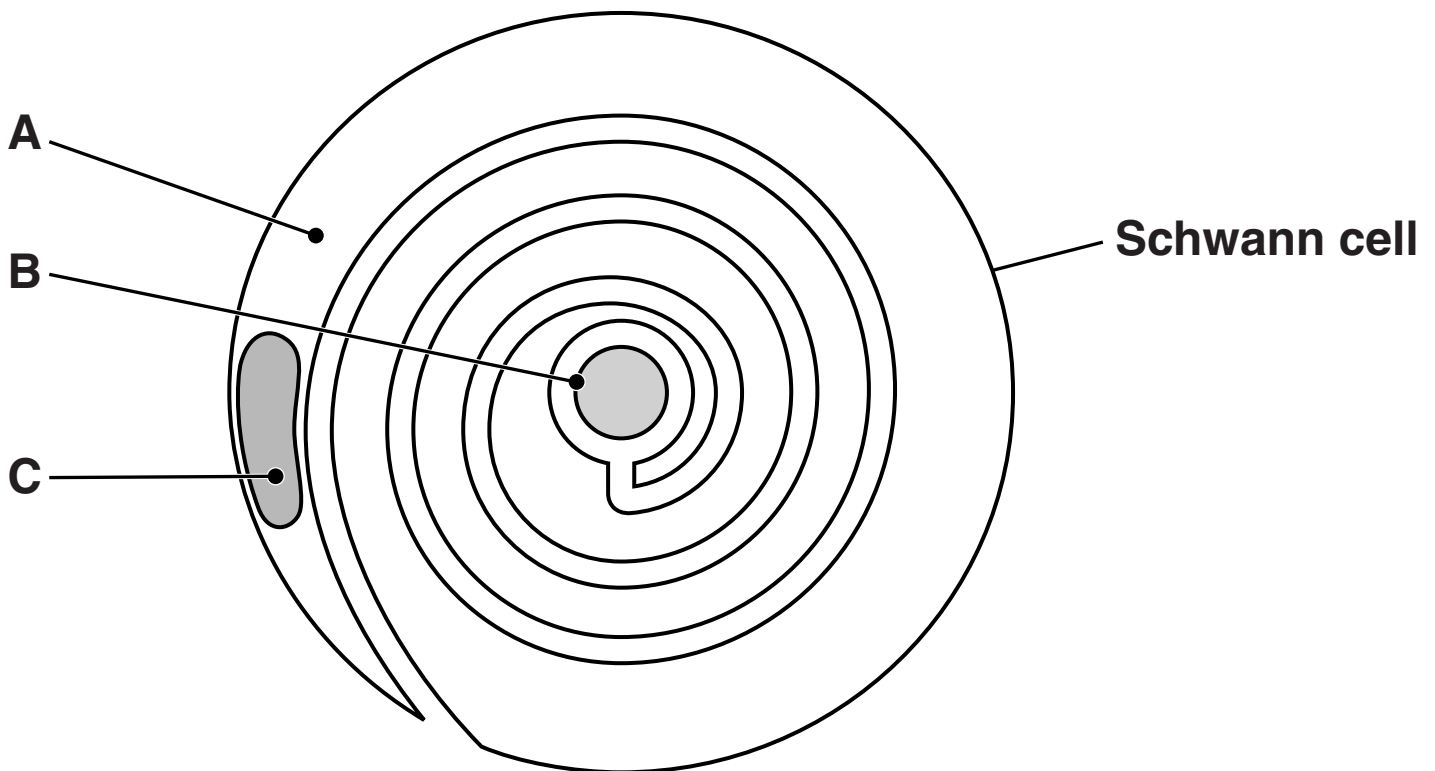
- The number of marks is given in brackets [] at the end of each question or part question.
- The total number of marks for this paper is 60.
-  Where you see this icon you will be awarded marks for the quality of written communication in your answer.
- You may use an electronic calculator.
- You are advised to show all the steps in any calculations.
- Any blank pages are indicated.

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Answer ALL the questions.

- 1 (a) Fig. 1.1 represents a cross section through a myelinated neurone.**

FIG. 1.1



- (i) Identify A to C.**

A _____

B _____

C _____

[3]

- (ii) Name the gap between two adjacent Schwann cells along the length of the neurone.**

_____ **[1]**

- (b) There are a number of differences between myelinated and non-myelinated neurones. One difference is the distribution of voltage-gated sodium ion channels in the membrane.**

MYELINATED NEURONE

voltage-gated sodium ion channels only occur at gaps between Schwann cells

each gap is approximately $2\mu\text{m}$ long

gaps occur at approximately $1000\mu\text{m}$ intervals

NON-MYELINATED NEURONE

voltage-gated sodium ion channels occur along the total length of the neurone

Use the information on page 5 to explain the difference in the speed of conduction of an action potential along the length of a myelinated neurone and a non-myelinated neurone.

[4]

- (c) A family of membrane proteins known as SNARE proteins are attached to vesicle membranes and cell surface membranes.**

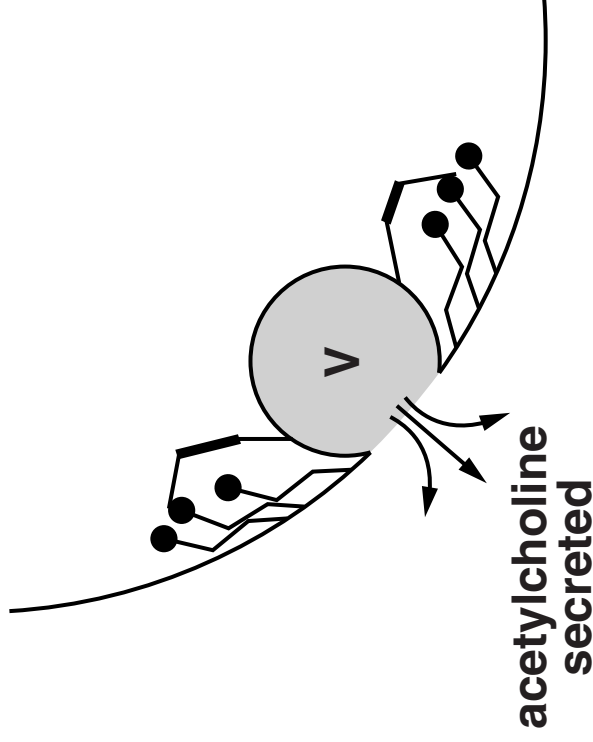
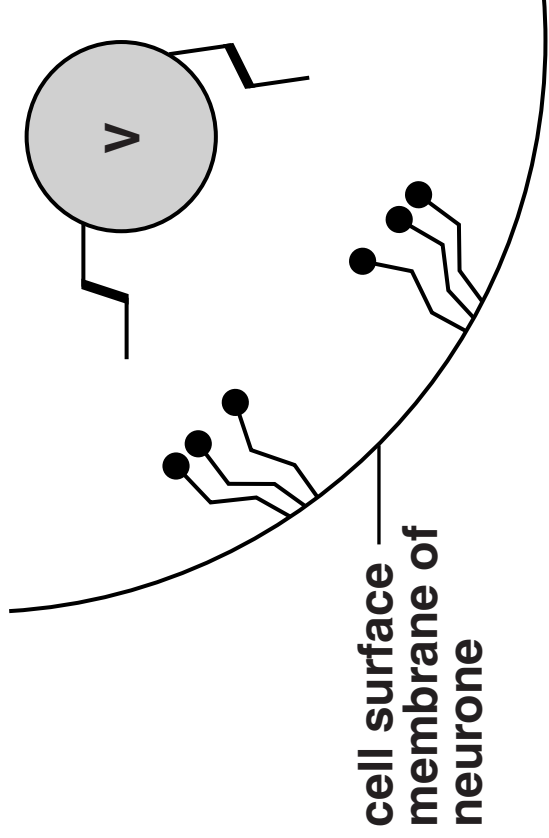
Fig. 1.2 (opposite) summarises the mechanism by which vesicles secrete acetylcholine from a neurone.

FIG. 1.2

Vesicle (V) has a type of SNARE protein attached to its membrane. This protein is known as vesicle associated membrane protein (VAMP).

The cell surface membrane of the neurone has a complex of SNARE proteins attached to it.

When the VAMP protein locks onto the SNARE complex, it enables the vesicle membrane to fuse with the cell surface membrane. This allows secretion of acetylcholine from the neurone.



- (i) Name the process by which the acetylcholine is secreted.

_____ [1]

- (ii) Name the part of a neurone from which acetylcholine is secreted.

_____ [1]

- (iii) Botulinum toxin is a protease that is produced by the bacterium, Clostridium botulinum.

If this toxin is present in the body, for example as a result of eating contaminated food, the toxin enters neurones.

With reference to Fig. 1.2, suggest, with reasons, the effects that botulinum toxin may have once it has entered a neurone.

_____ [2]

[TOTAL: 12]

2 The maintenance of a stable body temperature is an important aspect of homeostasis in endotherms. This is known as thermoregulation.

(a) (i) State where the CORE body temperature is monitored.

_____ [1]

(ii) Name the type of sensory cell in the skin that detects changes in environmental temperature.

_____ [1]

(iii) Name the corrective homeostatic mechanism that works to restore any changes in body temperature to the normal range.

_____ [1]

(b) Endotherms respond in different ways to changes in environmental temperature. Some of these responses are listed below:

| | |
|----------|--|
| J | secretion of adrenaline |
| K | sweating |
| L | shivering |
| M | contraction of erector pili muscles (attached to base of hairs) |
| N | curling up |
| O | finding shade |
| P | vasoconstriction of arterioles near to skin surface |

Use the letters, J to P, to identify:

(i) the responses that conserve heat.

_____ **[1]**

(ii) the responses that cool the body.

_____ **[1]**

(iii) a physiological response that generates heat.

_____ **[1]**

(iv) a behavioural (not physiological) response to a decrease in environmental temperature.

_____ **[1]**

- (c) Different endotherms have evolved different physiological and behavioural adaptations to assist with temperature control.**

Explain how each of the following adaptations help the animal to control its body temperature.

- (i) Elephants have large, thin ears that they move backwards and forwards when hot.**

[2]

- (ii) Penguins living in cold climates have ‘shunt’ blood vessels. These shunt vessels link arterioles carrying blood towards their feet with small veins that carry blood away from their feet.**

[1]

[TOTAL: 10]

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- 3 As blood passes through the kidney it is filtered and the urine formed in the nephron leaves the kidney through the ureter.

Table 3.1 below shows the concentration of some of the components of blood, glomerular filtrate and urine.

TABLE 3.1

| Component | Blood (g 100cm⁻³) | Glomerular filtrate (g 100cm⁻³) | Urine (g 100cm⁻³) |
|-----------------------------------|---|---|---|
| Glucose | 0.10 | 0.10 | 0.00 |
| Urea | 0.03 | 0.03 | 1.80 |
| Amino acids | 0.05 | 0.05 | 0.00 |
| Large proteins | 8.00 | 0.00 | 0.00 |
| Inorganic ions (total) | 0.90 | 0.90 | variable, up to 3.60 |

Table 3.2 below shows the presence or absence of erythrocytes in blood, glomerular filtrate and urine.

TABLE 3.2

| Component | Blood | Glomerular filtrate | Urine |
|---------------------|----------------|----------------------------|---------------|
| Erythrocytes | present | absent | absent |

(a) Explain the changes in fluid composition shown in Table 3.1 and Table 3.2.



In your answer, you should use appropriate technical terms, spelled correctly. [5]

[illegible]

- (b) Kidney function can be assessed by measuring the Glomerular Filtration Rate (GFR). GFR is a measure of the rate at which blood is filtered by the kidneys.**

The GFR is estimated using the concentration of creatinine in the blood plasma. This compound is produced naturally by the body and is normally filtered from the blood by the kidneys and excreted.

- (i) Suggest what a high concentration of creatinine in the blood plasma indicates about kidney function. Give a reason for your answer.**

[1]

- (ii) A formula is used to obtain a value for GFR that takes into account the various factors that contribute to concentration of creatinine in the blood.

GFR is expressed as $\text{cm}^3 \text{min}^{-1}$.

A typical person is assumed to have a body surface area of 1.73m^2 .

In order to obtain an estimate of GFR (eGFR) for individuals who are smaller or larger than a typical person, the following calculation is performed:

$$\text{eGFR} = \text{GFR} \times \frac{1.73}{\text{individual's body surface area}}$$

A man has a GFR of $82 \text{cm}^3 \text{min}^{-1}$ and a body surface area of 2.56m^2 .

Calculate the eGFR for this man.

Show your working and give your answer to the nearest WHOLE NUMBER.

eGFR = _____ $\text{cm}^3 \text{min}^{-1}$ [2]

- (iii) Chronic Kidney Disease (CKD) is divided into five stages according to the eGFR value.

These stages are listed in Table 3.3 below.

TABLE 3.3

| CKD stage | eGFR ($\text{cm}^3 \text{min}^{-1}$) | Effect on kidney |
|------------------|--|---------------------------------------|
| 1 | greater than 90 | little or no damage |
| 2 | 60 – 90 | some or no damage |
| 3 | 30 – 59 | moderate reduction in function |
| 4 | 15 – 29 | severe reduction in function |
| 5 | less than 15 | kidney failure |

Use the information in Table 3.3 to:

identify the CKD stage indicated by the eGFR that you calculated in (b)(ii)

determine the effect on the kidney of this man.

stage _____

effect on kidney _____

[1]

- (c) The following are some of the pieces of information relating to kidney transplantation that have appeared in some news items during the last 15 years.**

November 2002

The trade in human organs is growing. One woman sold her kidney for £400 (two year's worth of her wages) to an agent. The agent then sold it for an estimated £20 000 to a man who was in desperate need of a transplant.

November 2010

A private medical group has admitted to the charge of carrying out illegal kidney transplants at one of its hospitals. The people from whom the kidneys were taken were poor and some were below the legal age of consent. They were paid for the kidneys, which were sold to wealthy people who needed transplants.

April 2011

The number of people donating one of their kidneys for transplant is increasing year by year. The donor receives no payment, undergoes months of medical and psychiatric tests, and cannot specify who receives their kidney. While the numbers of donors are still small compared to the numbers needing a kidney transplant, each kidney donated is making the difference between life and death for someone.

Discuss, with reference to the information given on pages 18–19, whether it is ethical for live donors to be used as a source of kidneys for transplantation.

[3]

[TOTAL: 12]

4 Organisms respond to changes in their internal environment. These responses are controlled by nervous and hormonal mechanisms.

(a) The concentration of blood glucose is regulated by hormones.

Complete the passage below, using the MOST SUITABLE term in each case.

The pancreas releases hormones directly into the blood and these regulate the concentration of blood glucose. The pancreas, therefore, acts as an _____ gland.

When the blood glucose concentration increases, insulin is released from the beta cells in the regions of the pancreas known as the _____ .

A different hormone, glucagon, is released from the alpha cells of the pancreas and this hormone causes _____ to be broken down into glucose, in a process known as _____ .

[4]

(b) The heart rate is controlled by both nervous and hormonal mechanisms.

(i) Name ONE hormone which will INCREASE the heart rate.

_____ **[1]**

(ii) State ONE way in which the nervous system DECREASES the heart rate.

_____ **[1]**

[TOTAL: 6]

5 (a) Glycolysis is the initial stage of cellular respiration.

(i) State PRECISELY where in the cell glycolysis occurs.

_____ **[1]**

(ii) Outline the process of glycolysis.



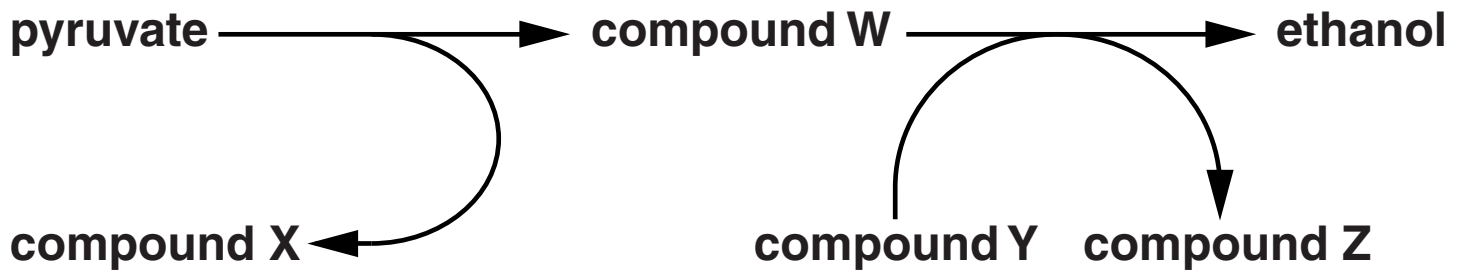
In your answer, you should use appropriate technical terms, spelled correctly.

_____ **[4]**

(b) Yeast cells can carry out ANAEROBIC respiration.

Fig. 5.1 outlines the process of anaerobic respiration in yeast.

FIG. 5.1



Identify the compounds W to Z.

W _____

X _____

Y _____

Z _____

[4]

- (c) In South-East Asia the main source of commercial sugar is the palm, Borassus flabellifer. Sap of this species has a high sugar content. Yeasts and bacteria, however, can contaminate the sap as it is collected and ferment the sugar, producing ethanol. This contamination makes it less suitable as a source of sugar.

A study was carried out to investigate the effect of three treatments traditionally used to reduce fermentation during the collection of the sap. The sap is treated in one of the following ways:

with a weak alkaline solution (treatment A)

with bark from the tree Vateria copallifera (treatment V)

with bark from the tree Careya arborea (treatment C)

The sap was collected from the palm trees over a 60-hour period. Samples of the collected sap were taken at 15 hour intervals. In each sample, the concentration of alcohol and the number of bacteria were recorded.

The results are shown in Table 5.1.

TABLE 5.1

| TREATMENT | SAMPLE TIME (HOURS) | ALCOHOL CONCENTRATION (%) | NUMBER OF BACTERIA (10⁶ cm⁻³) |
|---------------------------------------|------------------------------------|--|--|
| CONTROL (NO TREATMENT) | 15 | 0.2 | 19 |
| | 30 | 3.5 | 800 |
| | 45 | 5.2 | 2200 |
| | 60 | 2.6 | 3400 |
| A | 15 | 0.0 | 3 |
| | 30 | 0.1 | 4 |
| | 45 | 0.2 | 5 |
| | 60 | 0.3 | 7 |
| V | 15 | 0.2 | 110 |
| | 30 | 1.1 | 2900 |
| | 45 | 1.2 | 2400 |
| | 60 | 1.8 | 2000 |
| C | 15 | 0.4 | 230 |
| | 30 | 1.1 | 160 |
| | 45 | 1.3 | 3 |
| | 60 | 3.6 | 40 |

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-
-
- [2]

-
-
-
-
-
- [1]**

- (iii) To be used as a source of commercial sugar, the sap needs to be as uncontaminated as possible.**

Suggest, with a reason, which of the treatments shown in Table 5.1 would be the best for use with sap so that it is suitable as a source of commercial sugar.

[2]

[TOTAL: 14]

- 6 The molecules listed below are all associated with photosynthesis.**

AMINO ACID

ATP

CARBON DIOXIDE

GLYCERATE-3-PHOSPHATE (GP)

OXYGEN

REDUCED NADP

RIBULOSE BISPHTHOSPHATE (RuBP)

RUBISCO

TRIOSE PHOSPHATE (TP)

WATER

From these molecules, identify:

(a) the enzyme.

_____ **[1]**

(b) a product of the light-dependent reaction that is USED in the light-independent reaction.

_____ **[1]**

(c) a 3-carbon compound.

_____ **[1]**

(d) a compound that can be made from TP but is NOT part of the Calvin cycle.

_____ **[1]**

(e) a 5-carbon compound.

_____ **[1]**

(f) a product of the light-dependent reaction that IS NOT used in the light-independent reaction.

_____ **[1]**

[TOTAL: 6]

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional answer space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margins.

[illegible]

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