Answer **all** the questions.

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

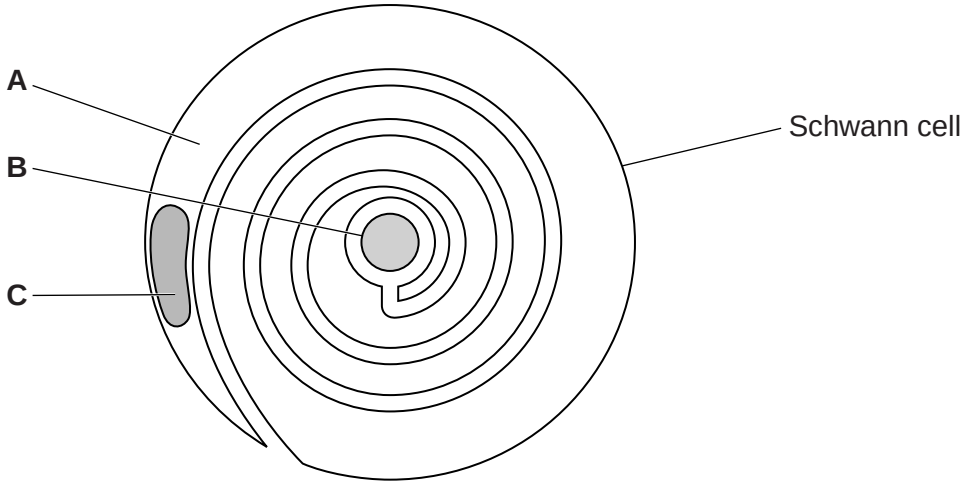

Fig. 1.1

(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 μm long
- gaps occur at approximately 1000 μm intervals

non-myelinated neurone

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

Use the information above 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.

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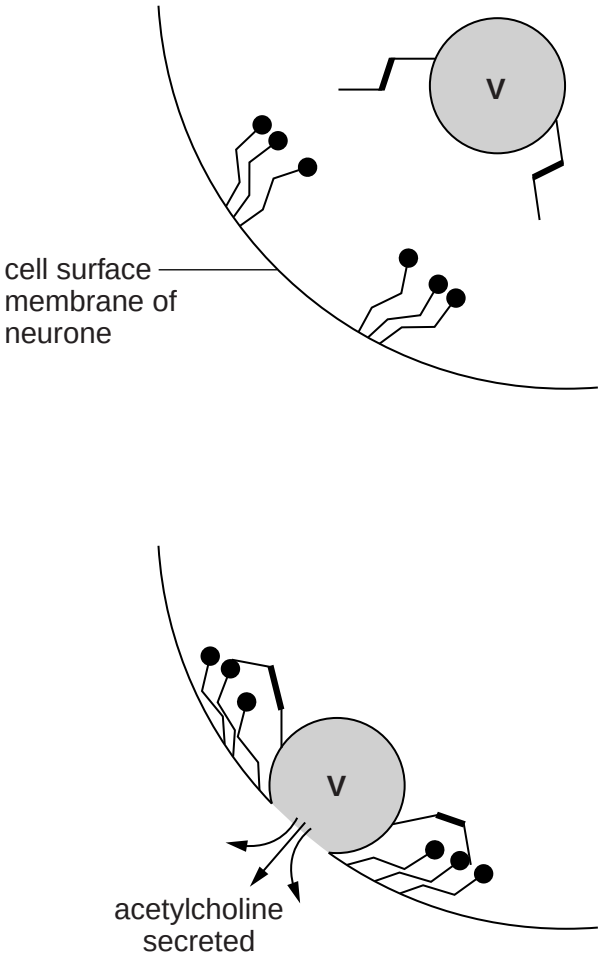
..... **[4]**

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

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



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.

Fig. 1.2

(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.

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..... **[2]**

[Total: 12]

Turn over

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.

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..... **[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.

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..... **[1]**

[Total: 10]

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.

Component	Blood ($g\,100\,cm^{-3}$)	Glomerular filtrate ($g\,100\,cm^{-3}$)	Urine ($g\,100\,cm^{-3}$)
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 3.1

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

Component	Blood	Glomerular filtrate	Urine
Erythrocytes	present	absent	absent

Table 3.2

(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]

(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.

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..... **[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 $cm^3\,min^{-1}$.

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

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:

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

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

Calculate the eGFR for this man.

Show your working and give your answer to the nearest **whole number**.

eGFR = ... $cm^3\,min^{-1}$ **[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.

CKD stage	eGFR ($cm^3 min^{-1}$)	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

Table 3.3

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 page 12, whether it is ethical for live donors to be used as a source of kidneys for transplantation.

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..... **[3]**

[Total: 12]

Turn over

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.

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..... **[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.

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..... **[4]**

(b) Yeast cells can carry out **anaerobic** respiration.

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

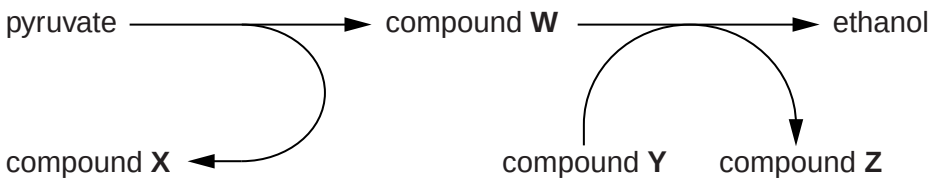

Fig. 5.1

Identify the compounds **W** to **Z**.

W .....

X .....

Y .....

Z .....

[4]

Turn over

(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.

Treatment	Sample time (hours)	Alcohol concentration (%)	Number of bacteria (10^6 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

Table 5.1

(i) With reference to Table 5.1, describe the effect of the different treatments on the alcohol concentration of the treated samples compared with the control samples.

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..... **[2]**

(ii) Suggest a reason for the difference in alcohol concentration **at 60 hours** between the two bark treatments **V** and **C**.

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..... **[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.

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..... **[2]**

[Total: 14]

Turn over

6 The molecules listed below are all associated with photosynthesis.

amino acid	**reduced NADP**
ATP	**ribulose bisphosphate (RuBP)**
carbon dioxide	**rubisco**
glycerate-3-phosphate (GP)	**triose phosphate (TP)**
oxygen	**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