Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel Level 3 GCE

Time 2 hours

Paper reference **9BN0/02**

Biology A (Salters Nuffield)

Advanced

PAPER 2: Energy, Exercise and Co-ordination

You must have:
Ruler, pencil and calculator

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- **Show all your working out** in calculations and **include units** where appropriate.
- Answer the questions in the spaces provided – *there may be more space than you need.*

Information

- The total mark for this paper is 100.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*
- You may use a scientific calculator.
- In questions marked with an **asterisk** (*), marks will be awarded for your ability to structure your answer logically, showing how the points that you make are related or follow on from each other where appropriate.

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over

©2022 Pearson Education Ltd.

Pearson

Answer ALL questions. Write your answers in the spaces provided.

Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 Blood from the lungs returns to the left side of the heart in the pulmonary vein. The pulmonary vein does not have valves.

(a) (i) Describe how the atrioventricular (AV) valves work during one cardiac cycle.

(2)

.....

.....

.....

.....

.....

.....

(ii) The structure of the pulmonary vein is different from the structure of the pulmonary artery.
Explain how this difference is related to the function of the pulmonary vein.

(2)

.....

.....

.....

.....

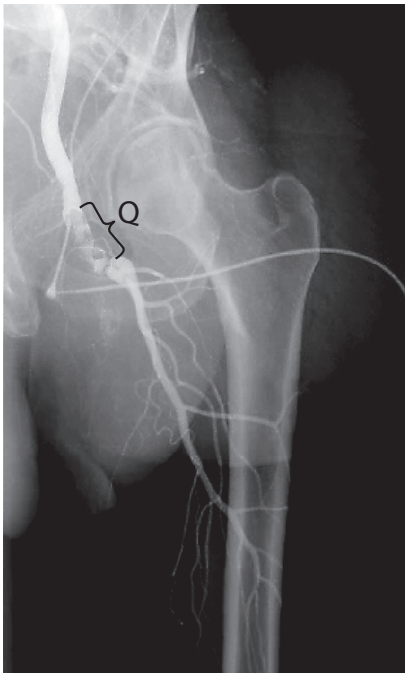
.....

.....

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

(b) An angiogram is an X-ray image of a blood vessel. To produce an angiogram, a dye is added to the blood. The dye does not let X-rays through.

This angiogram shows the location of a blood clot (labelled Q) in a vein near the hip of a patient.



(Source: © ZEPHYR/SCIENCE PHOTO LIBRARY)

(i) Which of the following is released by platelets at location Q?

(1)

☒ **A** fibrin

☒ **B** prothrombin

☒ **C** thrombin

☒ **D** thromboplastin

(ii) Which of the following is an enzyme that converts a soluble plasma protein into an insoluble protein at location Q?

(1)

☒ **A** fibrinogen

☒ **B** prothrombin

☒ **C** thrombin

☒ **D** thromboplastin

(Total for Question 1 = 6 marks)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

2 The human brain is an organ that has a range of functions.

(a) A student produced a table linking three descriptions of brain function to a labelled diagram of the brain.

Label	Description of function of labelled region in brain
1	Site where more synapses are formed during the critical window for vision
2	Required for the fine motor skills to draw a straight line
3	Area that sends impulses to the sinoatrial node (SAN) in response to a lowering of blood pH

Which diagram of the brain correctly matches the table?

(1)

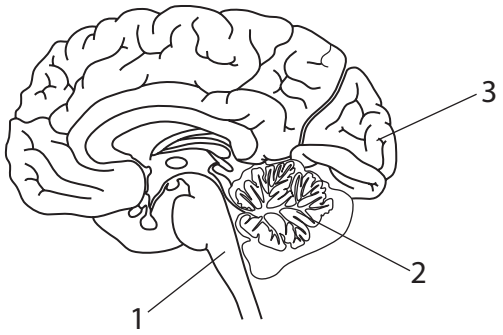


Diagram A

☒

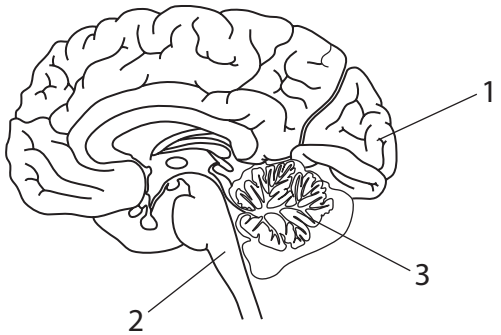


Diagram B

☒

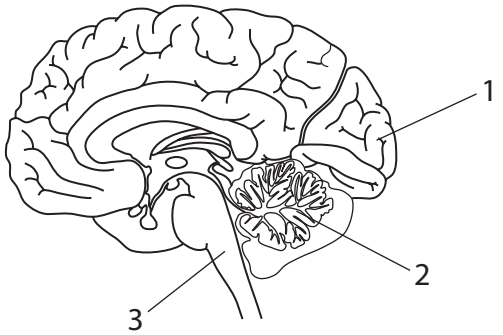


Diagram C

☒

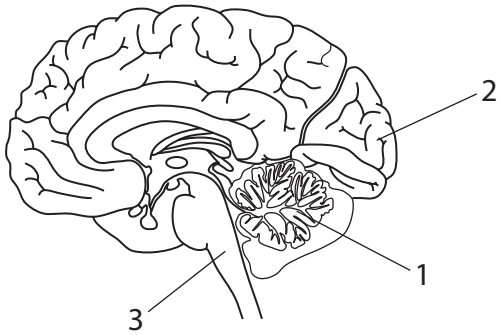


Diagram D

☒

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

(b) There are various types of scan that can be used to study the brain.

(i) Describe why a region of the brain might appear lighter in an image obtained by a functional magnetic resonance image (fMRI) scan.

(3)

.....

.....

.....

.....

.....

.....

.....

.....

.....

(ii) One scan combines positron emission tomography (PET) and computed tomography (CT). This scan can be used to show whether a person has cancer.

Describe why a combined PET and CT scan may be better for diagnosing cancer than a PET or CT scan on its own.

(3)

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Total for Question 2 = 7 marks)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

3 Some lipoproteins may reduce fertility in mammals.

(a) An investigation was carried out using mice of the same breed.

Female mice were divided into three groups, P, Q and R. Each group was given a different treatment.

The table shows the treatment given to the three groups of female mice.

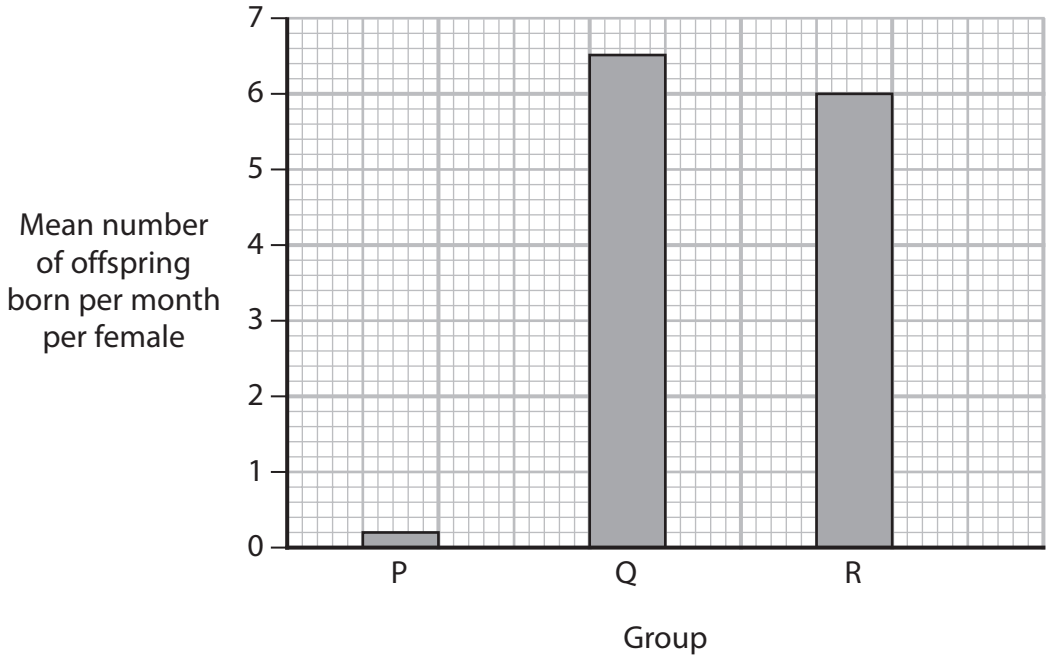
Group	Treatment
P	Genetically modified (GM) only
Q	Genetically modified and supplied with drug K
R	Supplied with drug K only

The GM mice have an increased concentration of high-density lipoproteins (HDLs) in their blood plasma.

Drug K was used to lower the blood plasma HDL levels.

The mice in each group were allowed to breed with non-genetically modified male mice and the number of offspring born was recorded.

The graph shows the results.



DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

(i) The mice were all of one breed to improve data

(1)

- ☒ **A** accuracy
- ☒ **B** precision
- ☒ **C** quantity
- ☒ **D** validity

(ii) State a null hypothesis for this investigation.

(1)

.....

.....

.....

(iii) Comment on the effect of blood plasma HDL levels on the fertility of these female mice.

(4)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

(b) Which of the following are always the same for both mammalian sperm and egg cells of the same species?

1. The total mass of nuclear DNA
2. They both release enzymes by exocytosis

(1)

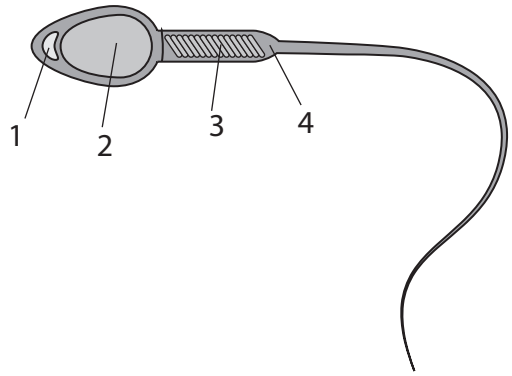
☒ **A** Neither of them

☒ **B** 1 only

☒ **C** 2 only

☒ **D** 1 and 2

(c) The diagram shows a mammalian sperm cell.



Which of the labelled parts contains enzymes that phosphorylate glucose during respiration?

(1)

☒ **A** 1

☒ **B** 2

☒ **C** 3

☒ **D** 4

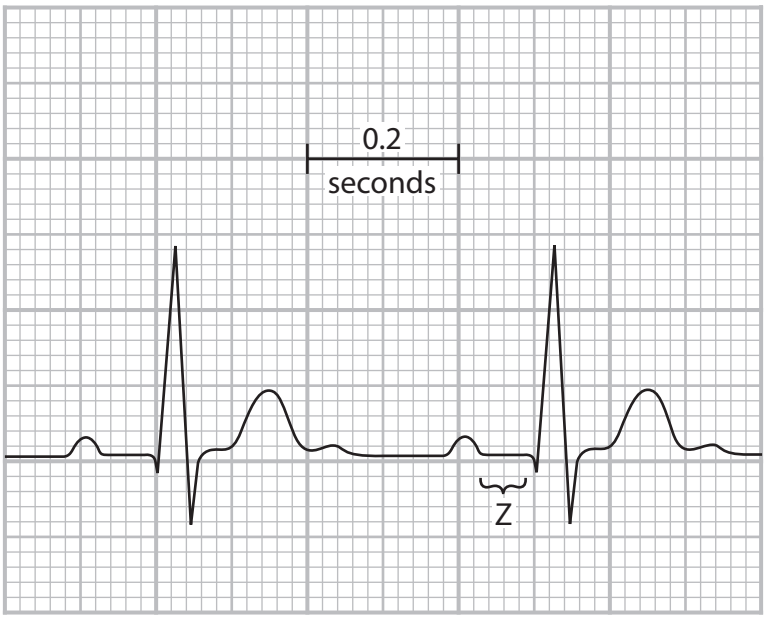
(Total for Question 3 = 8 marks)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

4 A person arrived at hospital having eaten some poisonous berries.

(a) An electrocardiogram (ECG) was recorded for this person.

The diagram shows part of the ECG obtained.



(i) Tachycardia for an adult is defined as a heart rate above 100 beats per minute.

Calculate the percentage increase above 100 beats per minute for the heart rate of this person.

(2)

Answer .....%

(ii) The length of time labelled Z on the ECG was shorter than for a person with a normal heart rate.

Which of the following is shown by label Z on the diagram?

(1)

☒ **A** the time that the atria are contracting

☒ **B** the time for the atrioventricular (AV) valves to open

☒ **C** the time that the atrioventricular node (AVN) delays depolarisation

☒ **D** the time that the ventricles are contracting

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

(b) One of the poisons in the berries can bind to acetylcholine receptors on the surface membrane of cells in the SAN. This prevents acetylcholine binding to the receptors if it is in low concentration.

This person was treated with a drug that stopped acetylcholinesterase from being released into the synaptic gap.

Explain how this drug lowered the heart rate of this person.

(3)

.....

.....

.....

.....

.....

.....

.....

.....

.....

(c) The poison also caused the pupils of this person to dilate.

Describe the interaction of the muscles in the eye that led to this dilation of the pupils.

(3)

.....

.....

.....

.....

.....

.....

.....

.....

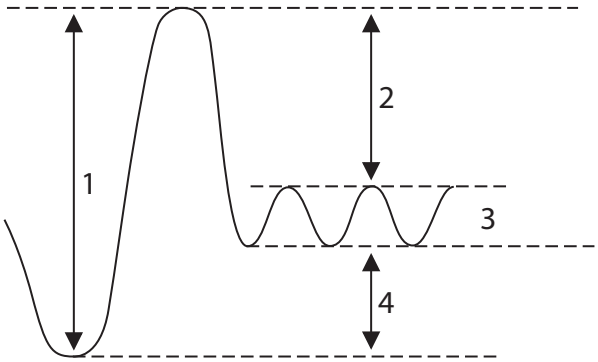
.....

(Total for Question 4 = 9 marks)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

5 A spirometer can be used to study aspects of the human respiratory system.

(a) The diagram shows a trace produced using a spirometer.



Which of the following parts of the spirometer trace could be used to determine the maximum volume of air that can be exhaled?

(1)

☒ **A** 1 only

☒ **B** 2 and 3 combined

☒ **C** 3 only

☒ **D** 3 and 4 combined

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

(b) The availability of oxygen in the air is lower at high altitudes because of the lower air pressure.

Populations of humans that have lived at high altitude for many generations have adapted to these conditions.

One adaptation these people have is a larger thorax than people living at lower altitudes.

A student made the following hypothesis:

People with this adaptation will have a lower breathing rate as their tidal volume will be greater than those without the adaptation.

(i) Devise a valid investigation, using a spirometer, to test this hypothesis.

(4)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA

(ii) Another adaptation to living at high altitude is to have more red blood cells circulating in their blood.

Explain how a bone marrow stem cell can give rise to red blood cells.

(4)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

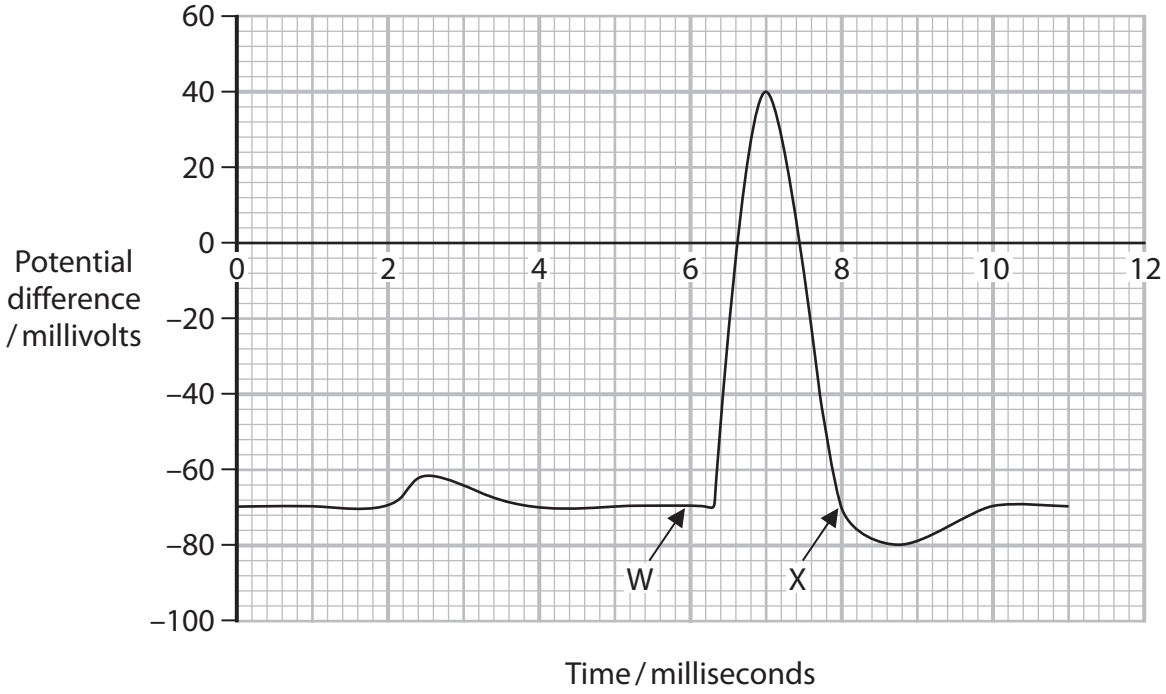
.....

(Total for Question 5 = 9 marks)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

6 The nervous system is one of the features found only in animals.

(a) The graph shows the change in potential difference across the cell surface membrane of a neurone when it is stimulated at point W.



(i) The threshold intensity is the minimum electrical stimulus that will cause a neurone to form an action potential.

Which potential difference could be the threshold potential for this neurone?

(1)

☒ **A** –80 millivolts

☒ **B** –70 millivolts

☒ **C** –60 millivolts

☒ **D** 40 millivolts

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

(ii) Explain the changes in the sodium and potassium ion concentrations in the cytoplasm of the neurone from point W to point X on the graph.

(4)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(iii) Explain why the neurone becomes hyperpolarised after point X on the graph.

(3)

.....

.....

.....

.....

.....

.....

.....

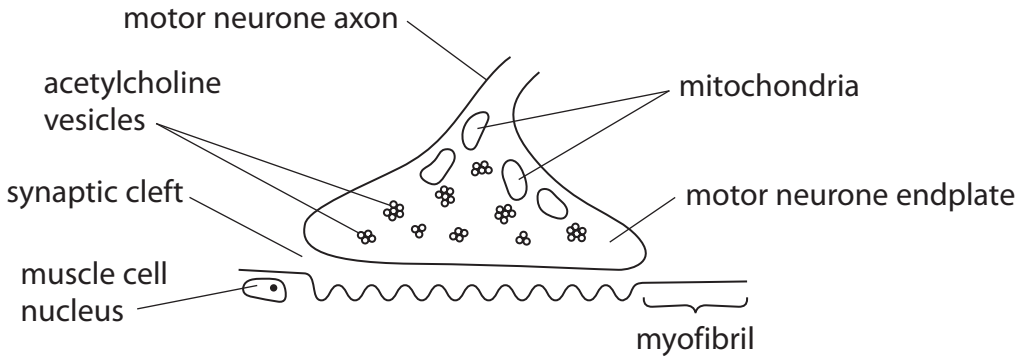
.....

.....

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

(b) The junction between the end of a motor neurone and a muscle myofibril is a modified synapse.

The diagram shows this neuromuscular junction.



Describe how the neurotransmitter crosses this synapse.

(2)

.....

.....

.....

.....

.....

.....

(Total for Question 6 = 10 marks)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

7 Athletes compete in a range of environmental conditions.

(a) An investigation studied the effects of environmental conditions on athletes.

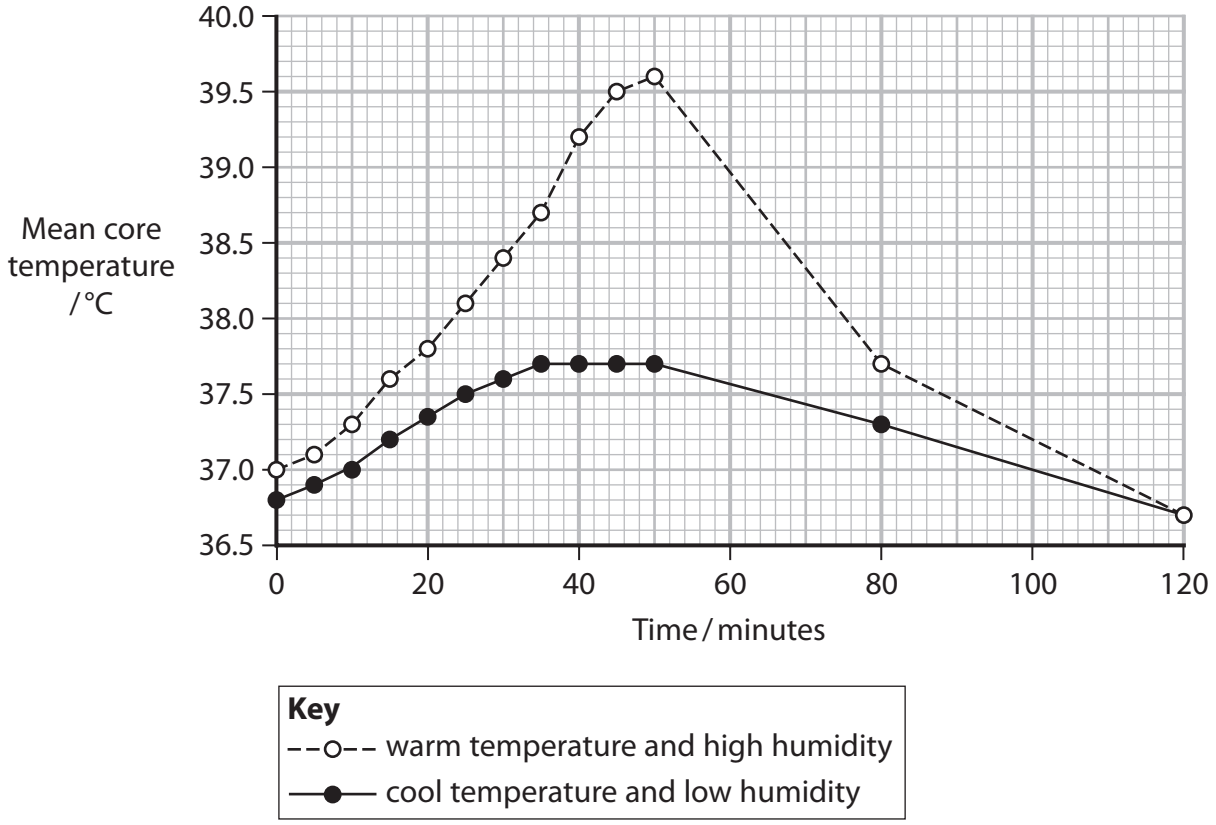
A group of nine athletes ran for 50 minutes in two sets of environmental conditions:

- warm temperature and high humidity
- cool temperature and low humidity.

All other variables were kept constant including the level of exercise.

The core temperature of each athlete was recorded during the exercise and for 70 minutes following the exercise.

The results are shown in the graph.



(i) Explain why there was a change in core temperature during the first 20 minutes of exercise.

(2)

.....

.....

.....

.....

.....

.....

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

(ii) Using the results of this investigation, a student concluded that during exercise:

- the human thermoregulatory system only works in cool environmental temperatures when the humidity is low.

Comment on this conclusion.

(4)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(iii) Compare and contrast the changes in core body temperature, in the two environments, after the exercise was completed.

(3)

.....

.....

.....

.....

.....

.....

.....

.....

.....

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

(b) In another investigation, samples of blood were taken from athletes during exercise and after exercise.

The concentration and activity of neutrophils, a type of phagocyte, in the blood were measured.

The table shows the results.

Measurements	During exercise	Immediately after exercise
Mean concentration of neutrophils in blood / 10^6 cells cm^{-3}	3.57	3.42
Mean activity of neutrophils / a.u.	28.4	22.0

(i) The mean body mass of the athletes was 70 kg and the mean volume of blood per athlete was 5 dm^3.

Calculate how many fewer neutrophils there are in the blood per kilogram of body mass immediately after exercise.

(3)

..... kg^{-1}

(ii) State how these results support the statement that exercise increases the risk of infection.

(1)

.....

.....

.....

(Total for Question 7 = 13 marks)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

8 Cells can be classified as either prokaryotic or eukaryotic.

(a) Which row identifies the type of DNA found in prokaryotic cells?

(1)

		Plasmid DNA is	Chromosomal DNA is
☒	**A**	double-stranded	double-stranded
☒	**B**	double-stranded	single-stranded
☒	**C**	single-stranded	double-stranded
☒	**D**	single-stranded	single-stranded

(b) Eukaryotic cells contain a range of membrane-bound organelles including the Golgi apparatus and the rough endoplasmic reticulum (rER).

(i) Name two other organelles that are bound by a single membrane.

(1)

.....

.....

.....

DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA

(ii) The table shows the percentage of cell membranes that make up Golgi apparatus and rER in the cells from two organs.

Organ	Percentage of cell membranes (%)	
	Golgi apparatus	rER
Liver	7	35
Pancreas	10	60

Explain the differences in the percentage of membranes that comprise the two organelles in these cells.

(5)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

(c) In one study, measurements were taken of a single Golgi apparatus.

The measurements were:

- total number of cisternae = 6
- height of each cisterna = 15 nm
- distance between adjacent cisterna = 25 nm

Calculate the total height of the stack of cisternae in this Golgi apparatus.

Give your answer in micrometres.

(2)

..... μm

(d) Beetroot cells contain the pigment betalain.

When beetroot cells are placed in alcohol, the concentration of betalain in the cells changes.

Explain why alcohol affects the concentration of betalain in these cells.

(3)

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Total for Question 8 = 12 marks)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

9 The inheritance of coat colour in mice has been investigated.

Some scientists crossed mice that had yellow coats. The offspring had either yellow coats or non-yellow coats.

(a) (i) Explain how the scientists knew which allele for coat colour was recessive.

(2)

.....

.....

.....

.....

.....

.....

(ii) The crosses led to a total of 1599 offspring being produced.

Predict the number of yellow and non-yellow offspring produced.

(2)

Offspring with a yellow coat	Offspring with a non-yellow coat

(iii) The table shows the actual number of offspring with each coat colour.

Offspring with a yellow coat	Offspring with a non-yellow coat
1064	535

Explain why there are differences between the predicted and actual numbers of these mice.

(3)

.....

.....

.....

.....

.....

.....

.....

.....

.....

DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA

*(b) There is a gene in humans similar to the mouse coat colour gene.

This human gene comprises 74 775 base pairs. The mRNA produced from this gene codes for a protein made up of 132 amino acids.

Explain the differences in the gene coding for this protein and the mRNA produced from it.

(6)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Total for Question 9 = 13 marks)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

10 All mammals have an internal skeleton that includes bone and cartilage. Bones contain calcium ions.

(a) Explain one way in which cartilage at the ends of the bones in the knee joint reduces wear and tear.

(2)

.....

.....

.....

.....

.....

.....

(b) In humans, calcium ions are important for structure as part of bone material. These ions are also involved in physiological processes in soft tissue. Soft tissue is non-bony material.

The table shows some data relating to humans.

mean mass of an adult	80 kg
mean percentage of body mass that is bone	4%
mean mass of calcium ions per adult	1000 g
mean percentage of calcium ions present in soft tissue	1%

(i) Calculate the calcium ion concentration in the soft tissue of a human.

(3)

..... $\mu g\ g^{-1}$

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

*(ii) Calcium ions are also found in the tissue of plants.

The calcium ion concentration in one species of plant has been measured.

It was found to be 170 $\mu g\ g^{-1}$ of plant tissue.

A student made the conclusion that:

Calcium ions are more important in the tissue of plants than in animals.

Evaluate this conclusion.

(6)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

(c) Milk from humans contains both calcium ions and lactose.

Lactose is a disaccharide.

Describe how lactose is formed from two monosaccharides.

(2)

.....

.....

.....

.....

(Total for Question 10 = 13 marks)

TOTAL FOR PAPER = 100 MARKS

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA