

PEARSON EDEXCEL IAL BIOLOGY • YBI11

BIOLOGY



EXAM QUESTION PACK

UNIT 5: RESPIRATION, MUSCLES AND THE INTERNAL ENVIRONMENT

SCORE

/213

PERCENTAGE

%

STEMUP

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Q1.

Alpha-1 antitrypsin (AAT) deficiency is an inherited disease that can affect different organ systems.

Alpha-1 antitrypsin (AAT) is a protein produced in the liver.

(a) Investigation of the breathing of a patient with AAT deficiency found that the:

- resting tidal volume (V_T) was 500 cm^3
- dead space (DS) was 150 cm^3
- resting respiratory rate (RR) was 12 breaths per minute.

Calculate the volume of air that enters the alveoli (A_V) **each hour**.

$$A_V = (V_T - DS) \times RR$$

Give your answer to 2 significant figures with appropriate units.

(3)

Answer

(b) Activity of the heart was investigated in the same patient.

The trace shows a normal electrocardiogram (ECG).



(i) Name the stage of the cardiac cycle at T on this ECG.

(1)

(ii) The ECG of the patient with AAT is shown in the trace.



Calculate the mean heart rate shown in this ECG trace.

(1)

Answer

(iii) Compare and contrast the ECG trace of this patient with the normal ECG trace.

(3)

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(c) One potential treatment for AAT deficiency uses adenoviruses to genetically modify cells in an affected person.

Adenoviruses contain double-stranded DNA.

Explain how adenoviruses can be used to treat AAT deficiency in a person.

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(Total for question = 12 marks)

Q2.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

The photograph shows a camel.



(Source: © Shengyong Li/Shutterstock)

Camels are an important livestock species. They are adapted to living in hot, dry environments.

(a) How many of the following adaptations enable a camel to reduce its water loss?

- production of very concentrated urine
- high glomerular filtration rate
- long loop of Henle
- reduced release of ADH

(1)

☒ **A** 0

- ☐ **B** 1
- ☐ **C** 2
- ☐ **D** 3

(b) The table shows the water use of five species of animal.

Species	Water use / $\text{cm}^3 \text{kg}^{-1} \text{day}^{-1}$	Mean mass / kg
buffalo	150	697
camel	57	850
goat	136	80
sheep	95	110
zebu	120	195

(i) Calculate the difference in the volume of water use in a day by a buffalo and a camel.

Give your answer in dm^3 to two significant figures.

(2)

Answer dm^3

(ii) Suggest two reasons why there is no correlation between water use and mean mass for the species given in the table.

(2)

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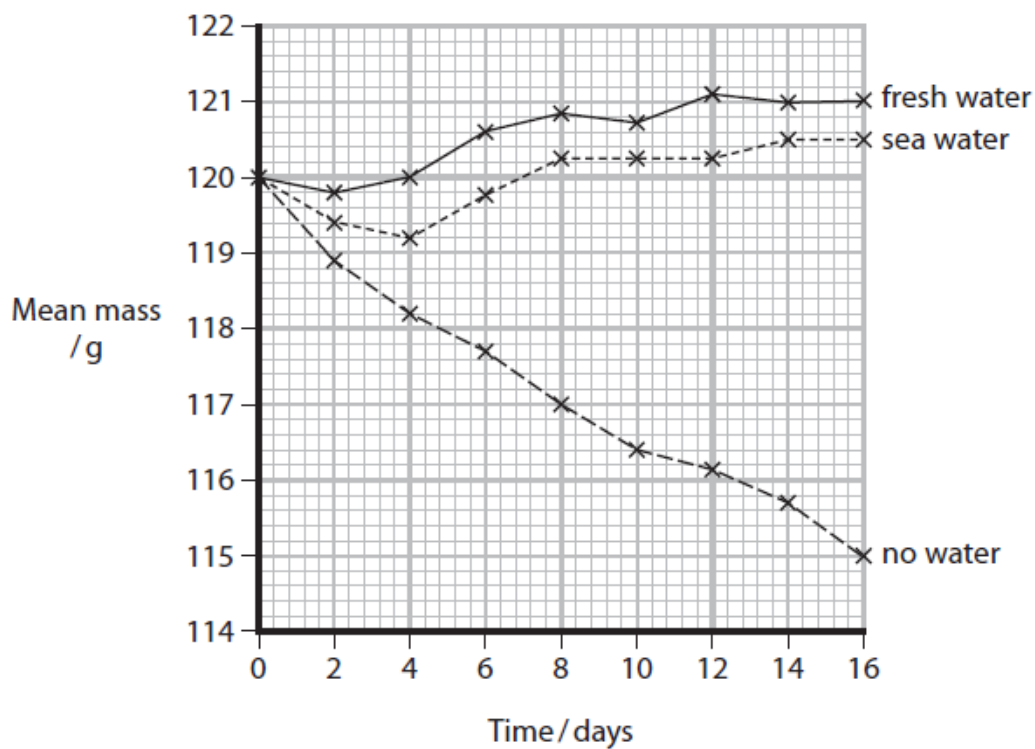
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(c) The kangaroo rat is another animal that lives in a hot, dry environment.

In an investigation, kangaroo rats were given either fresh water, sea water or no water.

The graph shows the mean body mass of kangaroo rats which were fed on a diet of soya beans over a 16-day period.



Determine the effect of the type of water given on the mean mass of the kangaroo rats in this investigation.

Use the information in the graph to support your answer.

(3)

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(d) The kangaroo rat's kidneys play an important role in the process of conserving water.

Explain how the nephrons (kidney tubules) in the kidneys of the kangaroo rat are able to produce very concentrated urine.

(2)

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Q3.

(Total for question = 10 marks)

Answer the question with a cross in the box you think is correct ☒ . If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒ .

Animals use aerobic and anaerobic respiration to produce ATP.

(a) Aerobic respiration has three stages where reactions occur between enzymes and substrates.

(i) Which row of the table shows the location of each stage?

(1)

	Glycolysis	Link reaction	Krebs cycle
☐ A	cytoplasm	cytoplasm	cytoplasm
☐ B	cytoplasm	mitochondrial matrix	mitochondrial matrix
☐ C	mitochondrial matrix	cytoplasm	cytoplasm
☐ D	mitochondrial matrix	mitochondrial matrix	mitochondrial matrix

(ii) A student calculated the volume of oxygen used by a cockroach as $1.7 \text{ cm}^3 \text{ hour}^{-1}$. The same cockroach produced $1.3 \text{ cm}^3 \text{ hour}^{-1}$ of carbon dioxide in the same time.

What is the respiratory quotient (RQ) of this cockroach?

(1)

- ☐ A 0.7
- ☐ B 0.8
- ☐ C 1.3
- ☐ D 2.2

(iii) Hydramethylnon is an insecticide that is used to treat termite infestations.

Hydramethylnon inhibits the electron transport chain.

Which row of the table shows the expected changes caused by hydramethylnon?

(1)

	Oxygen consumption	Lactate production
☐ A	decrease	decrease
☐ B	decrease	increase
☐ C	increase	decrease
☐ D	increase	increase

(b) The table shows the oxygen consumption and body mass of two animals.

Animal	Oxygen consumption / $\text{cm}^3 \text{h}^{-1}$	Body mass / g
Southern elephant seal	1.82×10^4	5.00×10^6
Field mouse	20.00	10.00

These figures can be used to calculate the metabolic rate of each animal in $\text{cm}^3 \text{g}^{-1} \text{h}^{-1}$.

Calculate how many times greater the metabolic rate of the field mouse is compared with that of the southern elephant seal.

(2)

Answer

* (c) The photograph shows a crocodile (*Crocodylus porosus*) that lives in saltwater habitats.



(Source: © Danny Ye/Shutterstock)

An investigation measured the lactate production rate of these crocodiles when they were active.

The graph shows the results of this investigation.

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(Total for question = 11 marks)

Q4.

In cells, energy can be released from substrates by anaerobic and aerobic respiration.

(a) Most eukaryotic cells can respire anaerobically.

(i) Which of the following describes a step in the process of anaerobic respiration?

(1)

- ☐ **A** decarboxylation of lactate
- ☐ **B** phosphorylation of hexoses
- ☐ **C** oxidation of pyruvate
- ☐ **D** removal of phosphate groups from glucose

(ii) What happens to the lactate concentration during a period of anaerobic respiration?

(1)

- ☐ **A** decreases, causing a decrease in blood pH
- ☐ **B** decreases, causing an increase in blood pH
- ☐ **C** increases, causing a decrease in blood pH
- ☐ **D** increases, causing an increase in blood pH

(b) Most eukaryotic cells are also able to respire aerobically.

(i) How do respiratory substrates enter the Krebs cycle?

(1)

- ☐ **A** as molecules containing 2 carbon atoms produced by the link reaction

- ☐ **B** as molecules containing 3 carbon atoms produced by the link reaction
- ☐ **C** as molecules containing 2 carbon atoms produced by RUBISCO
- ☐ **D** as molecules containing 3 carbon atoms produced by RUBISCO

(ii) Draw a diagram of a mitochondrion.

Label only the part of the mitochondrion where the Krebs cycle occurs.

(2)

(iii) Describe the role of chemiosmosis in the synthesis of ATP.

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(Total for question = 10 marks)

Answer the question with a cross in the box you think is correct ☒ . If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒ .

Aerobic respiration involves four main stages:

glycolysis, link reaction, Krebs cycle and oxidative phosphorylation.

(a) One product of all three stages shown in the table is ATP (adenosine triphosphate).

Complete the table to show one other product of each stage.

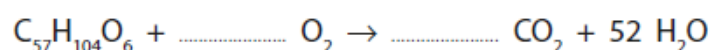
(3)

Stage	One other product
glycolysis	
Krebs cycle	
oxidative phosphorylation	

(b) An incomplete equation for the aerobic respiration of a substrate is shown below.

Complete the equation by inserting the numbers on the dotted lines to balance it.

(2)



(c) One molecule of glucose contains 2867.48 kJ of energy.

One molecule of glucose generates a maximum of 38 molecules of ATP in aerobic respiration.

A molecule of ATP contains 30.51 kJ of usable energy. Usable energy is available for chemical reactions in the cell.

(i) Which reaction releases energy from ATP?

(1)

- ☐ **A** the conversion of ADP to ATP
- ☐ **B** the phosphorylation of ADP
- ☐ **C** the hydrolysis of ATP
- ☐ **D** the removal of adenosine molecules from ATP

(ii) Calculate the maximum percentage of energy in a glucose molecule that can be converted to usable energy in ATP.

(2)

Answer

(iii) Describe what happens to the energy that is not converted to usable energy in a muscle cell.

(2)

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(d) Describe how oxygen is involved in the production of ATP on the cristae in the mitochondria.

(2)

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(Total for question = 12 marks)

Q6.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ~~☒~~ and then mark your new answer with a cross ☒.

The human body responds to changes in both its internal and external environments.

(a) How many of these statements describe the effects of adrenaline in the "fight or flight" response?

- arterioles constrict in skeletal muscles
- glycogen is released from the liver
- the rate of food digestion decreases

(1)

☐ A 0

☐ B 1

☐ C 2

☐ D 3

(b) The heart responds to adrenaline by increasing cardiac output.

Cardiac output = heart rate $\times$ stroke volume

(i) Calculate the cardiac output for a person who has a heart rate of 77 bpm and a stroke volume of 70 cm³.

Give your answer to two significant figures in dm³ hour⁻¹.

(2)

Answer dm³ hour⁻¹

(ii) The formula shows how to calculate the cardiac index. This is a method of adjusting cardiac output values for the body surface area of an individual.

$$\text{cardiac index} = \frac{\text{cardiac output in dm}^3 \text{ min}^{-1}}{\text{body surface area in m}^2}$$

The table shows some information for cardiac output, body surface area and cardiac index for two individuals.

Individual	Cardiac output / dm ³ min ⁻¹	Body surface area / m ²	Cardiac index
A	6.7	1.92	
B		1.49	2.8

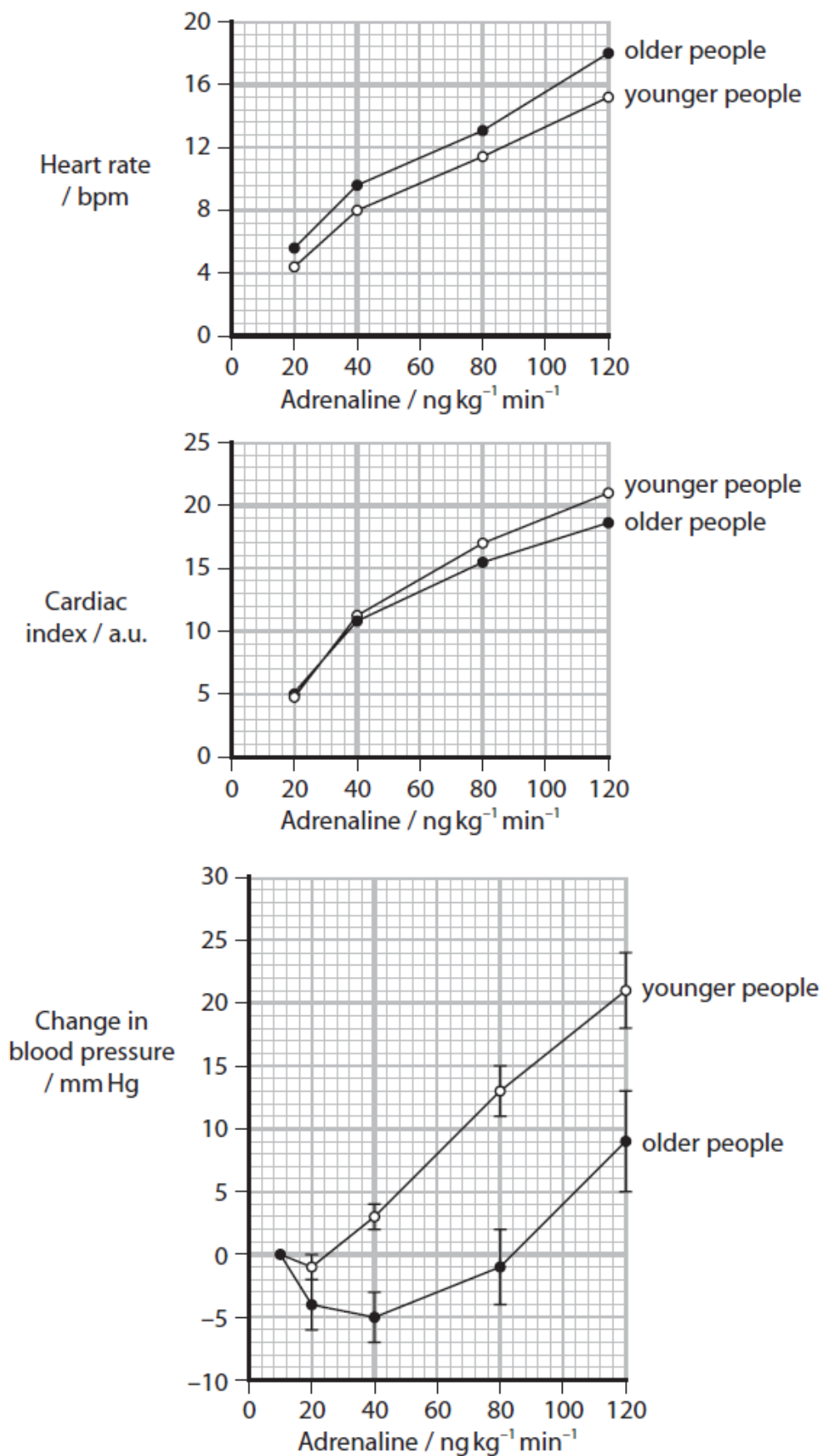
Complete the table to show the units for cardiac index, the cardiac index for individual A and the cardiac output for individual B.

(3)

*(iii) Ageing is associated with changes in the way the heart responds to adrenaline.

In an investigation, the effects of adrenaline on the hearts of young people and old people were recorded.

The graphs show the results of this investigation.



Discuss the effect of ageing on the response of the heart to adrenaline.

Use the information in the graphs to support your answer.

Q7.

The kidney is involved in the process of homeostasis in a mammal.

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How many of these parts of the kidney respond to ADH?

- Bowman's capsule
- collecting duct
- loop of Henle
- proximal tubule

(1)

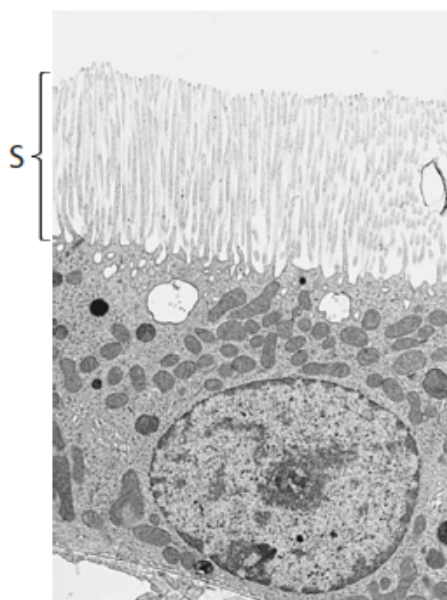
☐ **A** 1

☐ **B** 2

☐ **C** 3

☐ **D** 4

(b) The electron micrograph shows a transverse section of part of a proximal tubule.



(Source: <https://veteriankey.com/solute-reabsorption/>)

(i) Name the process by which the fluid moves from the plasma into the renal tubule (nephron).

(1)

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(ii) Name the structures labelled S.

(1)

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(c) A student compared the left renal veins of two individuals.

(i) The diameter of the left renal vein of one individual was 4.71 mm.

Calculate the cross-sectional area of this vein.

(2)

Answer mm²

(ii) The cross-sectional area of the left renal vein of the second individual was 0.194 cm².

Calculate the difference in the cross-sectional area in the left renal vein of these two individuals.

(1)

Answer

(d) The table shows the concentration of glucose and urea in the blood plasma, glomerular filtrate and urine of an individual.

Substance	Concentration in blood plasma / g dm ⁻³	Concentration in glomerular filtrate / g dm ⁻³	Concentration in urine leaving collecting duct / g dm ⁻³
glucose	1.50	1.50	0.00
urea	0.30	0.30	21.00

Explain the concentration of glucose and urea in the urine.

Use the information in the table to support your answer.

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(e) An individual produced 0.83 cm³ of urine each minute.

Calculate the volume of urine produced by this individual in 24 hours.

Assume the urine production is at a constant rate.

Give your answer in dm³, to two significant figures.

(2)

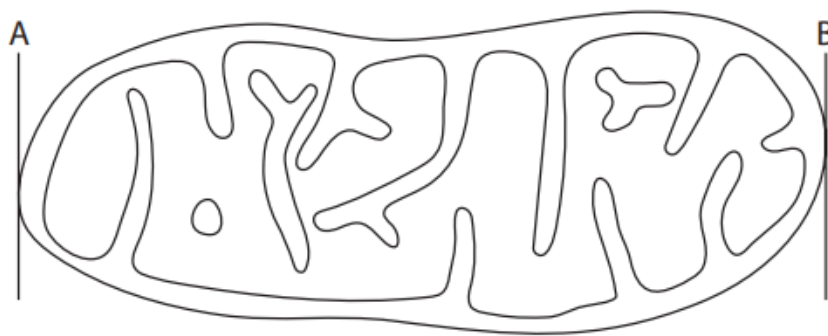
(Total for question = 11 marks)

Q8.

Answer the question with a cross in the box you think is correct ☐. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☐.

In eukaryotic organisms aerobic respiration takes place in mitochondria.

(a) The diagram shows a mitochondrion.



The actual length of the mitochondrion between A and B was 0.75 μm .

Calculate the magnification of the mitochondrion shown in the diagram.

Give your answer in standard form.

(2)

Answer

(b) In an investigation, the rate of production of carbon dioxide by mitochondria was measured.

Three samples of mitochondria had the following chemicals added to them:

- Sample 1: pyruvate
- Sample 2: pyruvate and ADP
- Sample 3: pyruvate and pyruvate transport inhibitor.

The table shows the results of this investigation.

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(ii) Describe the role of ATP in muscle contraction.

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(Total for question = 14 marks)

Q9.

The scientific document you have studied is adapted from articles in *StatPearls: Anatomy, Autonomic Nervous System*, *British Journal of Cardiology: Postural Orthostatic Tachycardia Syndrome (POTS)* and *Cellular and Molecular Life Sciences: The enteric nervous system in gastrointestinal disease etiology*.

Use the information from the scientific document and your own knowledge to answer the following questions.

(a) The autonomic nervous system regulates aspects of respiration (paragraph 1).

Describe how the autonomic nervous system regulates the breathing rate when a person is resting.

(4)

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(b) Explain how neurones can respond to different neurotransmitter substances (paragraph 4).

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(c) Suggest how the activity of the sympathetic nervous system in immune organs could regulate inflammation (paragraph 7).

(2)

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(d) Explain how an electrocardiogram could be used to show that a person has postural orthostatic tachycardia syndrome (POTS) (Box 1).

(2)

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(e) Explain how reflex circuits in the gut cause a bolus to move (paragraphs 10 and 11).

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(f) State what is meant by the term ischemia (paragraph 12).

(1)

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(g) Suggest why embryological ENS cells may fail to colonise the bowel in a developing embryo (paragraph 13).

(1)

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(h) Explain how the interaction of microbial and other factors could result in gastrointestinal inflammation such as IBD (Box 2).

(3)

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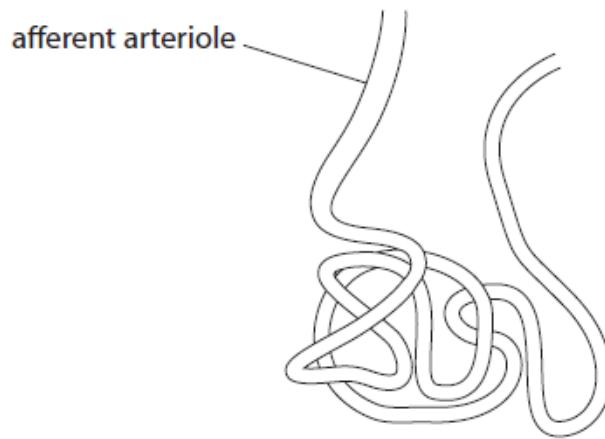
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Q10.

Answer the questions with a cross in the boxes you think are correct ☐. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☐.

The kidney is an organ that is involved in the removal of waste metabolites from the blood.

(a) The drawing shows the blood supply inside a Bowman's capsule (renal capsule).



(i) Complete the diagram to show the Bowman's capsule and label two structures in this diagram.

(3)

(ii) Which substances are normally filtered from the blood in the Bowman's capsule?

(1)

- ☒ **A** amylose and glucose
- ☒ **B** glucose and sodium chloride
- ☒ **C** potassium ions and haemoglobin
- ☒ **D** urea and prothrombin

(iii) Which row shows the route taken by a water molecule through a nephron in the kidney?

(1)

Route through a nephron →				
☐ A	collecting duct	proximal tubule	distal tubule	loop of Henle
☐ B	loop of Henle	proximal tubule	collecting duct	distal tubule
☐ C	proximal tubule	distal tubule	loop of Henle	collecting duct
☐ D	proximal tubule	loop of Henle	distal tubule	collecting duct

(b) Describe how glucose reabsorption takes place in the nephron.

(3)

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(c) Urea is produced by the metabolic breakdown of some organic molecules.

Which statement describes the production of urea?

(1)

- ☐ A in the kidneys from excess amino acids
- ☐ B in the kidneys from glycogen
- ☐ C in the liver from excess amino acids
- ☐ D in the liver from glycogen

(Total for question = 9 marks)

Q11.

Answer the question with a cross in the box you think is correct ☒ . If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒ .

The nervous system of an organism enables it to respond to a stimulus.

(a) A reflex action is a rapid involuntary movement in response to a stimulus. The response to a pinprick in a finger is an example of a reflex action.

(i) Which component of the nervous system continues a reflex arc immediately after the receptor has been stimulated by the stimulus?

(1)

- ☐ **A** motor neurone
- ☐ **B** relay neurone
- ☐ **C** Schwann cell
- ☐ **D** sensory neurone

(ii) Which pathway shows a reflex arc?

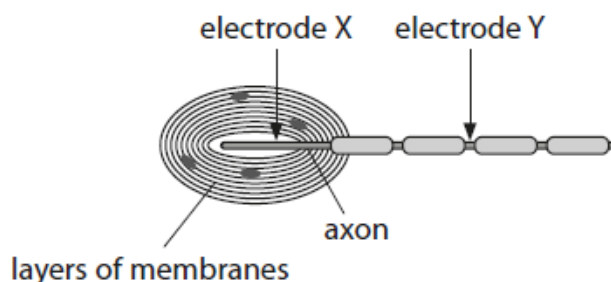
(1)

- ☐ **A** muscle → receptor → brain
- ☐ **B** muscle → spinal cord → brain
- ☐ **C** receptor → spinal cord → muscle
- ☐ **D** spinal cord → brain → muscle

(b) Pacinian corpuscles are pressure receptors found in the skin of the fingertip.

The effect of different pressures applied to the finger tip, on electrode potentials across the axon membrane of the neurone of a Pacinian corpuscle was investigated.

The diagram shows the structure of a Pacinian corpuscle and the location of electrodes, X and Y, used to measure axon membrane potentials.



The table shows the results of the investigation.

Pressure applied to the fingertip	Membrane potential at electrode X / mV	Membrane potential at electrode Y / mV
None	-70	-70
Low	-60	-70
Medium	+20	+40
High	+40	+40

(i) Describe how the resting potential of -70mV is maintained in the axon when no pressure is applied.

(3)

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(ii) Suggest how a change in pressure at the Pacinian corpuscle causes an action potential in the axon.

(3)

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(iii) Explain why the membrane potential at electrode Y was the same when medium or high

pressure was applied to the fingertip.

(3)

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(Total for question = 11 marks)

Q12.

Skeletal muscle is made of bundles of fibres.

(a) Describe the role of calcium ions in producing contraction of a muscle fibre.

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(b) The table shows some features of slow and fast twitch muscle fibres.

Feature of fibre	Slow twitch fibre	Fast twitch fibre
Number of mitochondria per fibre	Many	Few
Number of myoglobin molecules per fibre	Many	Few
Capillary network	Larger	Smaller
Contraction	Slow and sustained	Rapid and intense

Olympic marathon runners have a high proportion of slow twitch fibres in their muscles.

Explain how the features of slow twitch fibres, shown in the table, are of benefit to an Olympic marathon runner.

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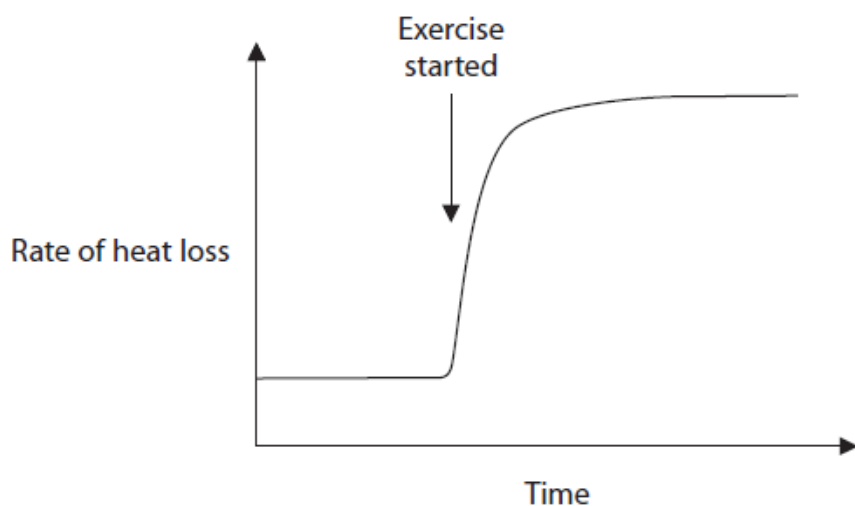
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(c) The graph shows the rate of heat loss at rest and during exercise.



Comment on the rate of heat loss during exercise.

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(Total for question = 8 marks)

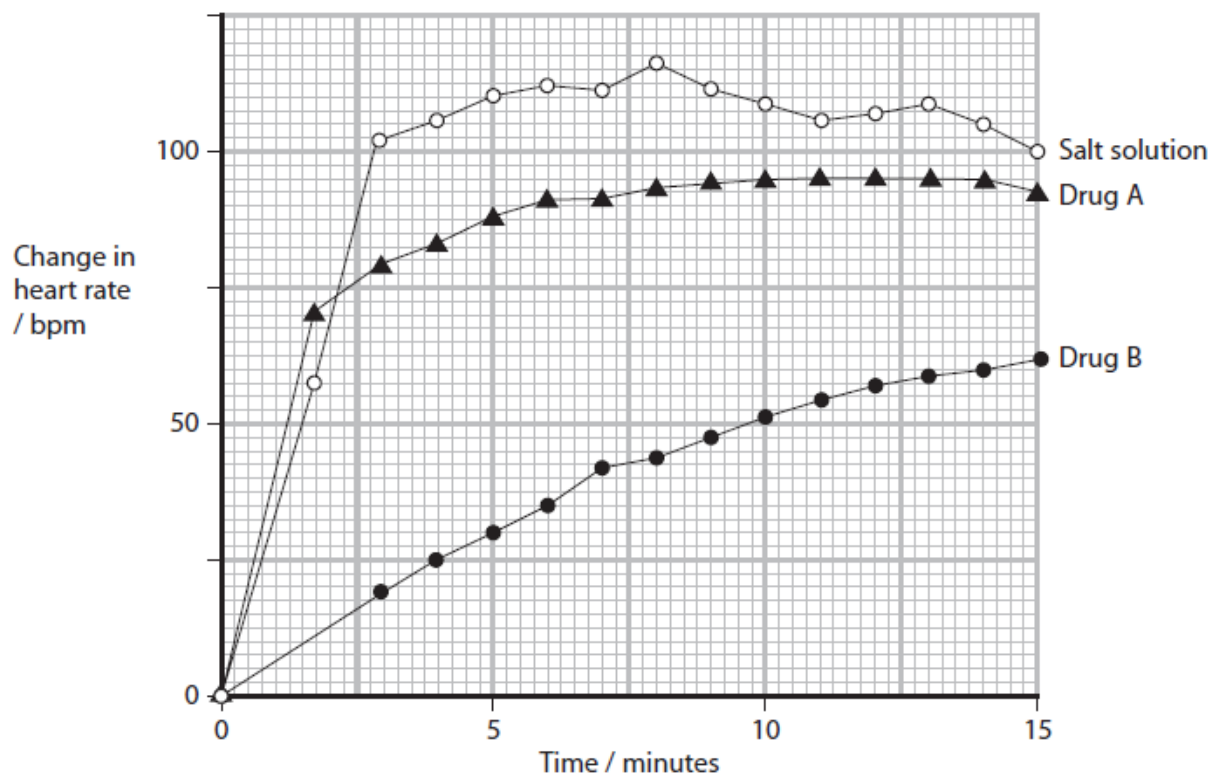
Q13.

Researchers investigated how groups of rats, treated with drugs, responded to stress.

Groups of rats were stressed by moving them into a new environment. The rats were then treated with a salt solution, drug A or drug B.

Group	Treatment
1	Salt solution
2	Drug A
3	Drug B

The graph shows the change in mean heart rate measured over a 15-minute period.



(a) Calculate the percentage difference in the change in heart rate when using drug B between 5 and 12.5 minutes.

(3)

Answer %

(b) Compare and contrast the effects of drug A and drug B on the heart rate during the investigation.

(3)

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(c) Explain the effect of these drugs on the control of the heart rate.

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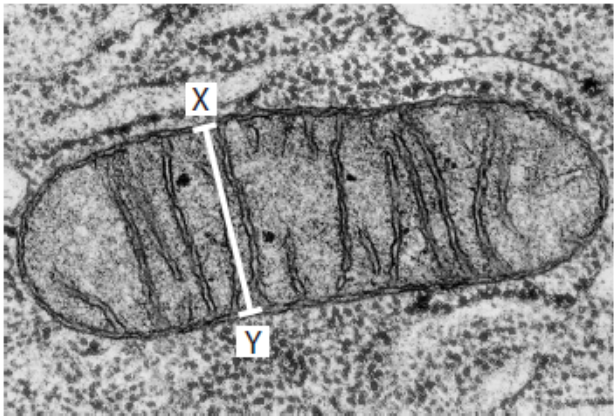
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(Total for question = 9 marks)

Q14.

The photograph shows a transmission electron micrograph of a mitochondrion and surrounding cytoplasm.



(Source: © CNRI / SCIENCE PHOTO LIBRARY)

(a) The mitochondrion shown in the diagram is 2000 nm in length.

Calculate the width of this mitochondrion between X and Y.

(2)

Answer nm

(b) Describe how ATP is synthesised by oxidative phosphorylation in the mitochondrion.

(3)

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(c) Describe how ATP is used to supply energy for biological processes.

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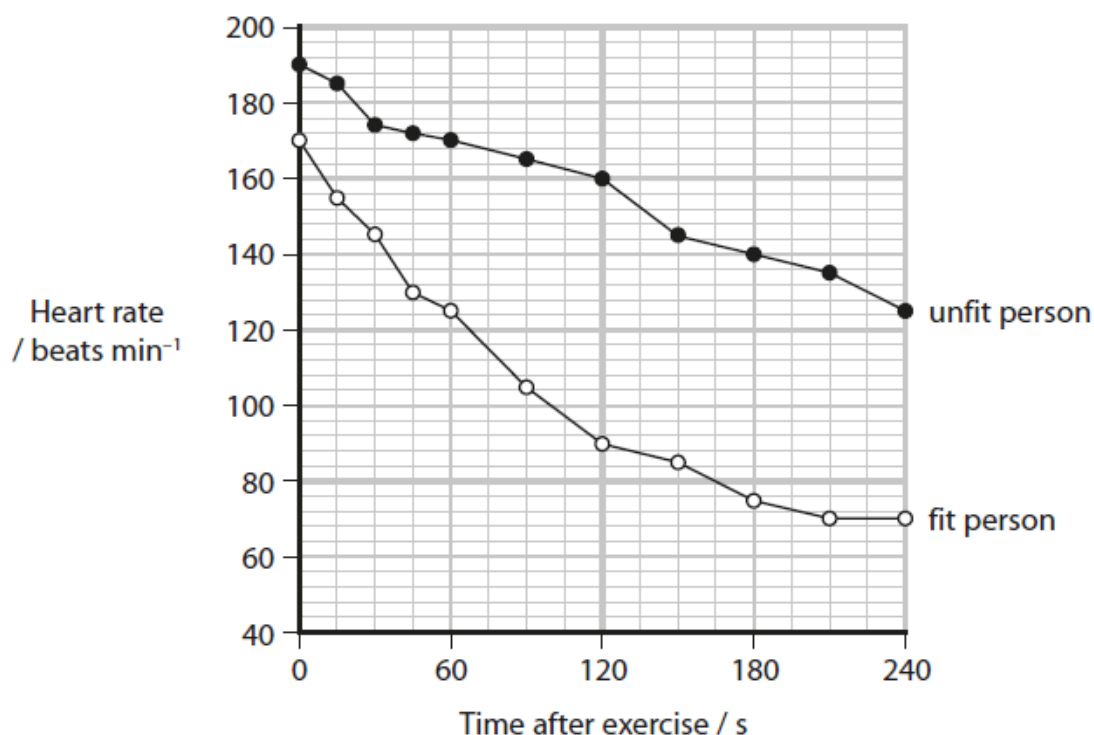
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(Total for question = 7 marks)

Q15.

Exercise affects the cardiac output of a person.

The graph shows the change in heart rate following exercise for an unfit person and for a fit person.



(a) The heart rate of the unfit person decreased by 16%, 120 seconds after exercise.

Calculate the difference in percentage decrease in heart rate of these two people, 120 seconds after exercise.

Give your answer to an appropriate number of decimal places.

(3)

Answer

(b) Calculate the heart rate of the unfit person at 5 minutes.

The change in heart rate of the unfit person is a linear relationship.
Use the equation for a straight line $y = mx + c$.

(3)

Answer

(c) Explain the difference in the time it would take for these two individuals to recover from the exercise.

(3)

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(d) Describe how heart rate is controlled in response to changes in the blood, following exercise.

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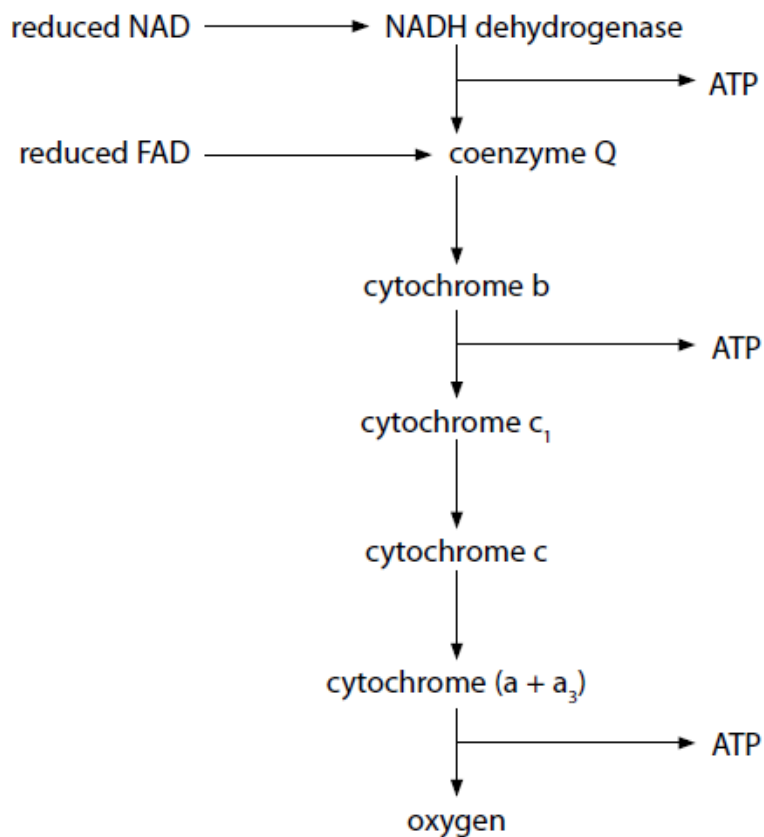
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(Total for question = 13 marks)

Q16.

The diagram shows the sequence of electron carriers in the electron transport chain.
The diagram also shows the stages where ATP is generated.



(a) Where is the site of the electron transport chain?

(1)

- ☐ **A** cytoplasm
- ☐ **B** inner mitochondrial membrane
- ☐ **C** matrix
- ☐ **D** outer mitochondrial membrane

(b) The table gives some information about inhibitors of the electron transport chain.

Inhibitor	Site of inhibition
Cyanide	between cytochrome (a + a ₃) and oxygen
Rotenone	between NADH dehydrogenase and coenzyme Q

(i) Explain the effect that cyanide will have on ATP production by the electron transport chain.

(2)

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(ii) Metabolism of succinate results in the production of reduced FAD.

Explain the effect that rotenone will have on ATP production by the electron transport chain.

(2)

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(iii) Explain why these inhibitors will not affect the production of ATP from anaerobic respiration. Use the information in the table to support your answer.

(2)

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(Total for question = 7 marks)

Q17.

Answer the question with a cross in the box you think is correct ☒ . If you change your mind about an answer, put a line through the box ☒ and then mark your new

answer with a cross ☒ .

Homeostasis is the state maintained by living systems.

(a) Feedback mechanisms are involved in maintaining homeostasis.

Describe the difference between a negative feedback mechanism and a positive feedback mechanism.

(2)

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(b) Which statement about the homeostasis of thermoregulation when the human body temperature is 37 °C is correct?

(1)

- ☐ **A** thermoregulation is no longer required
- ☐ **B** the body no longer generates any heat
- ☐ **C** the body will be generating more heat than it can lose
- ☐ **D** the body temperature is maintained in a dynamic equilibrium

(c) The health of a kidney can be determined by measuring the glomerular filtration rate (GFR).

This method measures the rate at which a small molecule called creatinine is filtered from the blood.

(i) Explain how small molecules like creatinine are filtered from the blood in the glomerulus.

(3)

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(ii) In 15 hours, a person excreted 1960 mg of creatinine in the urine.

Calculate the GFR for this person.

Give your answer to 3 significant figures.

(1)

Answer

(d) In type II diabetes, body cells take up less glucose in response to insulin.

Many people with type II diabetes are overweight or obese.

Some of these individuals have been given surgery to help weight loss.

A clinical trial investigated the effect of surgery on the uptake of glucose by body cells in the presence of insulin.

This trial used groups of people who were non-diabetic, people in the early stage of diabetes (pre-diabetic) and people who were type II diabetics.

Group	Mean uptake of glucose / a.u.	
	Before surgery	After surgery
Non-diabetic	1.07 ± 0.29	1.39 ± 0.58
Pre-diabetic	0.55 ± 0.32	1.30 ± 0.88
Type II diabetic	0.40 ± 0.24	1.10 ± 0.87

(i) Comment on the results of this trial.

(3)

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(ii) Calculate the difference that surgery makes to the mean uptake of glucose in the non-diabetic group and the type II diabetic group.

(2)

Answer

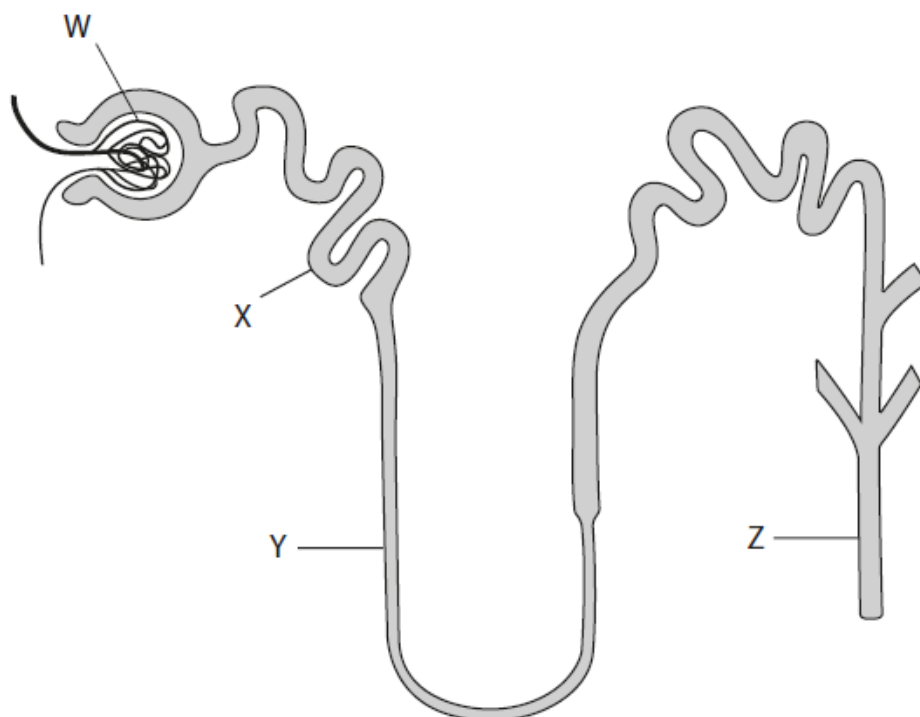
(Total for question = 12 marks)

Q18.

The kidney is an organ involved in the excretion of waste materials and in the regulation of blood volume and plasma concentration.

(a) The functional unit of the kidney is the nephron.

The diagram shows a single nephron.



(i) In which part of the kidney are structures W and X located?

(1)

☒ **A** cortex

- ☐ **B** inner medulla
- ☐ **C** outer medulla
- ☐ **D** renal pelvis

(ii) In which structure does ultrafiltration take place?

(1)

- ☐ **A** W
- ☐ **B** X
- ☐ **C** Y
- ☐ **D** Z

(iii) Which structures form part of the loop of Henle?

(1)

- ☐ **A** X only
- ☐ **B** X and Y
- ☐ **C** Y only
- ☐ **D** Y and Z

(b) Urea is a toxic substance that is excreted from the body.

Explain how ultrafiltration removes urea from the blood.

(2)

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(c) The kidney controls blood volume and plasma concentration by regulating the loss of water in urine.

Some mammals have adaptations to their kidneys that enable them to live in different habitats.

The table shows information about two small mammals.

Mammal	Urine concentration / mOsmol dm ⁻³	Relative number of mitochondria in the thick ascending loop of Henle	Sodium ion concentration of extracellular fluid in the medulla / mmol dm ⁻³
brown rat	2900	3.6	45
kangaroo rat	5500	5.5	95

Deduce why the kangaroo rat is more successful than the brown rat at living in desert habitats.

(3)

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(Total for question = 8 marks)

Q19.

Answer the question with a cross in the boxes you think are correct ☒. If you change your mind about an answer, put a line through the box ~~☒~~ and then mark your new answer with a cross ☒.

Whales are large mammals.

The photograph shows a beluga whale and a human diver.



(Source: © Andrey Nekrasov/Alamy Stock Photo)

(a) (i) A beluga whale can become habituated to human divers.

How many of the following statements about habituation are correct?

(1)

- habituation is an example of anatomical adaptation
- habituation is only observed in mammals
- habituation only occurs after repeated exposure to the same stimulus

☐ **A** 0

☐ **B** 1

☐ **C** 2

☐ **D** 3

(ii) A beluga whale can respond to a stimulus using a spinal reflex arc.

Which row is correct?

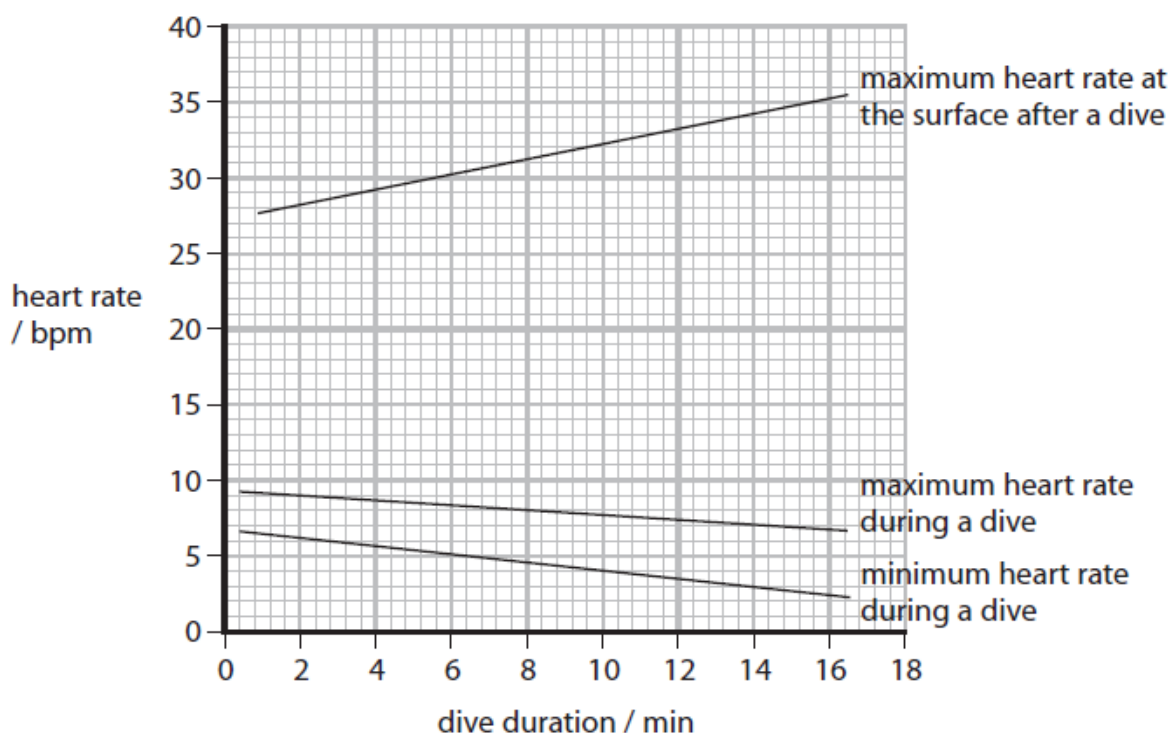
(1)

	Location of relay neurone	Location of cell body on the sensory neurone
☐ A	grey matter of spinal cord	at the end of the axon
☐ B	grey matter of spinal cord	in the middle of the axon
☐ C	white matter of spinal cord	at the end of the axon
☐ D	white matter of spinal cord	in the middle of the axon

(b) The heart rate of a whale changes when it is diving.

The graph shows the changes in heart rate that occur during dives of different durations.

The maximum heart rate at the surface is when the whale returns to the surface after a dive.



(i) Comment on the changes in heart rate of the whale when diving.

(3)

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(ii) Explain how the changes in heart rate are controlled when the whale returns to the surface immediately after the dive.

(3)

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(Total for question = 8 marks)

Q20.

Answer the questions with a cross in the boxes you think are correct ☒. If you change your mind about an answer, put a line through the box ~~☒~~ and then mark your new answer with a cross ☒.

Chemicals are used to regulate responses in both plants and animals.

(a) In mammals antidiuretic hormone (ADH) is involved in regulating plasma concentration and blood volume.

(i) Which of the following produces ADH?

(1)

- ☐ **A** adrenal gland
- ☐ **B** hypothalamus
- ☐ **C** medulla oblongata
- ☐ **D** pituitary gland

(ii) Which structures does ADH act on?

(1)

- ☐ **A** capillaries
- ☐ **B** collecting ducts
- ☐ **C** proximal tubules

☐ **D** ureters

(iii) The control of plasma concentration and blood volume in the body is an example of which type of process?

(1)

☐ **A** countercurrent multiplier

☐ **B** habituation

☐ **C** negative feedback

☐ **D** positive feedback

(iv) Name the type of receptor in the body that detects changes in the plasma concentration.

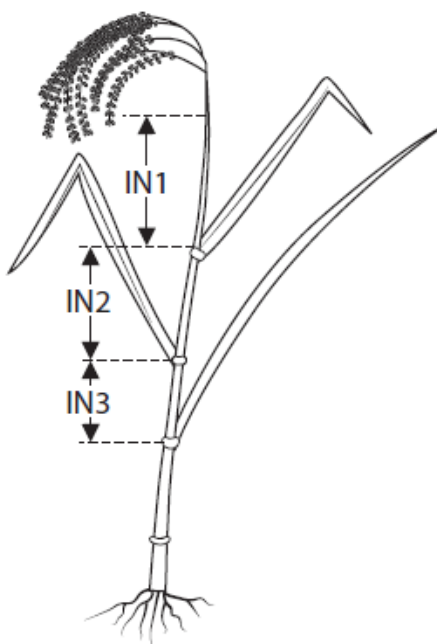
(1)

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(b) The effect of a gibberellin on the growth of cereal plants was investigated.

Different concentrations of the gibberellin were sprayed on cereal plants.

The lengths of the first, second and third internodes (IN1, IN2, IN3) were measured, as shown in the diagram.



The table shows the effect of the gibberellin on the mean lengths of the first, second and third internodes.

Concentration of the gibberellin / ppm	Mean length / cm		
	first internode	second internode	third internode
0	36	19	14
10	36	19	14
100	41	21	14
1000	52	22	15
2500	56	22	15

(i) Comment on the effect of the gibberellin on the growth of cereal plants.

(2)

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(ii) Suggest how the gibberellin causes this effect.

(3)

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(Total for question = 9 marks)

Mark Scheme

Q1.

Question number	Answer	Additional guidance	Mark
(a)	A calculation showing the following steps: - determination of tidal volume (1) - calculation of volume of air in 1 min (1) - calculation of volume of air in one hour (1)	$(500-150) = 350$ $350 \times 12 = 4.2 \text{ (dm}^3 \text{ min}^{-1}\text{)}$ Accept $4200 \text{ (cm}^3 \text{ min}^{-1}\text{)}$ $(4.2 \times 60) = 250 \text{ dm}^3 \text{ hour}^{-1}$ Accept $(4200 \times 60) = 250000 \text{ cm}^3 \text{ (hour}^{-1}\text{)}$ max 2 marks if no units / or incorrect units accept answer in standard form 2.5×10^5	(3)

Question number	Answer	Additional guidance	Mark
(b)(i)	An answer that includes the following point: (cardiac) diastole (1)		(1)

Question number	Answer	Additional guidance	Mark
(b)(ii)	100	accept 1.67 beats per second accept range 100 - 125	(1)

Question number	Answer	Additional guidance	Mark
(b)(iii)	An answer that includes three of the following points: Similarity - both traces have the same {PQRST/ described} wave (1) - R wave of similar height (1) Differences - normal ecg shows a lower heart rate (1) - in the patient trace the gap between T & P is shorter (1)	both show clear PQRST wave accept converse accept converse	(3)

Question number	Answer	Additional guidance	Mark
(c)	An answer that includes four of the following points: • {identification / isolation} of (corrected) AAT gene (1) • description of one enzyme used to insert gene (1) • adenoviruses can enter host cell (1) • and combine their own genetic material with that of the cell (1) • therefore a functional AAT protein can be produced (1)	E.g. cut the adenovirus DNA using the same restriction endonuclease / insert the gene into the adenovirus DNA using DNA ligase adenovirus acts as a vector	(4)

Q2.

Question number	Answer	Additional guidance	Mark
(a)	C is the correct answer • a high glomerular filtration does not enable the camel to reduce water loss • a slow release of ADH does not enable the camel to reduce water loss		Computer (1)

Question number	Answer	Additional guidance	Mark
(b)(i)	A calculation with the following steps • calculation of water use each day for camel and buffalo (1) • correct difference in dm³ to two significant figures(1)	$(57 \times 850) = 48450 \text{ cm}^3$ $(150 \times 697) = 104550 \text{ cm}^3$ $(104550 - 48450) \div 1000 = 56 \text{ (dm}^3\text{)}$ 56.1 = 1 mark Power of 10 error 1 mark eg 561 150-57=93 and then dividing by 1000 to get 0.093 = 1 mark	Graduate (2)

Question number	Answer	Additional guidance	Mark
(b)(ii)	An answer that includes the following points: - credit one adaptation / environmental condition (1) - credit second adaptation / environmental condition (1)	accept different habitat accept different environmental condition	Expert (2)

Question number	Answer	Additional guidance	Mark
(c)	An answer that includes three of the following points: (overall) both fresh water and sea water increased (mean) mass (of kangaroo rats) (1) - fresh water increased (mean) mass (of kangaroo rats) more than sea water - credit any calculated change in mass over days/ or daily change (1)	can piece together from separate descriptions of data accept fresh water caused the highest increase in (mean) mass e.g. 6 g difference between fresh and no water / 0.5 g difference between fresh and salt water / decrease of {0.2/0.6/1.8} g after 2 days / increase of {0.5 / 1} g after 16 days Fresh 0.83% and sea 0.42% daily	Expert (3)

Question number	Answer	Additional guidance	Mark
(d)	An answer that includes two of the following points: (nephron has) long(er) loop of Henle (1) - higher concentration of ions in the medulla (1) (kidneys/tubule/ DCT and collecting duct/ loop of Henle) reabsorb {large quantities of / more } water (1)	accept reference to counter current multiplier accept ADH results in increased absorption of water accept increased permeability to water in DCT and collecting duct accept ADH causes insertion of {water channels / aquaporins} in DCT and collecting duct	Expert (2)

Question number	Answer	Mark
(a)(i)	The only correct answer is B A is not the correct answer C is not the correct answer D is not the correct answer	1

Question number	Answer	Mark
(a)(ii)	The only correct answer is B A 0.7 is not the correct answer C 1.3 is not the correct answer D 2.2 is not the correct answer	1

Question number	Answer	Mark
(a)(iii)	The only correct answer is B A is not the correct answer as lactate production does not decrease C is not the correct answer as lactate production does not decrease D is not the correct answer as oxygen consumption does not increase.	1

Question number	Answer	Additional guidance	Mark
(b)	A calculation showing the following steps: - calculation of mouse and seal metabolic rate - quotient calculated	$20/10 = 2 \text{ cm}^3\text{g}^{-1}\text{h}^{-1}$ $18200/5000000 = 0.0036 \text{ cm}^3\text{g}^{-1}\text{h}^{-1}(0.00364)$ $2/0.0036 = 555.56/556/549.45/549/549.5$ Correct answer gains all 2 marks	2

Question number	Answer	Additional guidance	Mark
(c)	An answer that includes the following points: Indicative content - No direct relationship between body mass and lactate production - The larger the size of the crocodile the lower the rate of lactate production - Highest rate of lactate production in 20kg crocodiles - Smallest crocodiles have same rate of lactate production as 50kg crocodiles - Comment on the link between aerobic and anaerobic respiration Description of named responses - As crocodiles were exercising vigorously the aerobic pathway cannot keep up. - ATP generated anaerobically in glycolysis using glycogen stores in the muscle. - Energy used to allow the crocodile to move very rapidly, if only for a short time. Chemical nature of responses 1 mol of glucose from glycogen generates 3 mols of ATP and 2 mols of lactate - Detailed description of anaerobic pathway in glycolysis - Detailed description of aerobic pathways Detailed mechanism of responses Level 1: Description of (a minimum of 2 specific) results from experimental data.		6

	Level 2: All of level 1 plus reference to chemical nature of anaerobic or aerobic respiration Level 3: All of level 2 plus detailed mechanism for anaerobic and aerobic respiration		
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Q4.

Question number	Answer	Additional guidance	Mark
(a)(i)	B phosphorylation of hexoses		Computer (1)

Question number	Answer	Additional guidance	Mark
(a)(ii)	C increases, causing a decrease in blood pH		Computer (1)

Question number	Answer	Additional guidance	Mark
(b)(i)	A as molecules containing 2 carbon atoms produced by the link reaction		Computer (1)

Question number	Answer	Additional guidance	Mark
(b)(ii)	An answer that includes the following points: - double membrane structure with cristae (1) (mitochondrial) matrix identified as location of Krebs cycle reactions (1)	ALLOW Krebs cycle if arrow points to correct location. Allow without arrow labelled	Graduate (2)

Question number	Answer	Additional guidance	Mark
(b)(iii)	A description that includes five of the following points: - hydrogen atoms are transported to the electron transport chain (1) - by (the coenzymes) NAD and FAD (1) - electrons pass along the electron transport chain releasing energy (1) - that is used to move protons to the intermembrane space (1) - protons diffuse (back into the mitochondrial matrix) through ATP synthase (1) (catalysing) the formation of ATP from ADP and Pi (1)	ALLOW hydrogen ions and electrons ALLOW reduced NAD/NADH/NADH ₂ and reduced FAD/FADH/ FADH ₂ ALLOW H ⁺ /Hydrogen ions IGNORE ATPase ALLOW Phosphorylating ADP ALLOW correct equation	Expert (5)

Q5.

Question number	Answer	Additional guidance		Mark
(a)	An answer that includes the following points: - glycolysis completed correctly (1) - Krebs cycle completed correctly (1) - Oxidative phosphorylation completed correctly (1)	Accept products written in long hand eg Adenosine Triphosphate.		(3)
		Stage	One other product	
		glycolysis	pyruvate / reduced NAD/NADH	
		Krebs cycle	reduced NAD/NADH/FAD/FAD carbon dioxide/CO ₂	
		oxidative phosphorylation	water / H ₂ O/ NAD/FAD	

Question number	Answer	Additional guidance	Mark
(b)(i)	An answer that includes the following points: - correct number 80 O₂ (1) - correct number 57 CO₂ (1)		(2)

Question number	Answer	Additional guidance	Mark
(c)(i)	Choose an item. Correct answer C A is incorrect as energy is not released from ATP in the conversion of ADP to ATP B is incorrect as energy is not released from ATP in the phosphorylation of ADP D is incorrect as energy is not released from ATP in the loss of adenosine molecules from ATP		(1)

Question number	Answer	Additional guidance	Mark
(c)(ii)	A calculation showing the following steps: - calculation of energy from 38 ATP (1) - calculation of percentage of energy from glucose (1)	38 x 30.51 (1159.38) (1159.38/2867.48 x 100) = 40.43% Accept 40.4 Do not accept 40.5 or 40 Correct answer without working gains 2 marks	(2)

Question number	Answer	Additional guidance	Mark
(c)(iii)	An answer that includes the following points: - lost as heat (1) - increasing body temperature (1)	Both points may be in the same sentence	(2)

Question number	Answer	Additional guidance	Mark
(d)	A description that includes two of the following points: - oxygen is terminal electron acceptor / accepts electrons from electron transport chain (1) - forms H₂O / accepts H⁺ from reduced NAD/FAD (1)	Accept electrons cannot be passed along electron transport chain if no O ₂ to accept them (1)	(2)

Q6.

Question number	Answer	Mark
(a)	An answer that includes the following point: B 1 is the correct answer - A, 0 is not the correct answer as the third statement only is correct - C, 2 is not the correct answer as the third statement only is correct - D, 3 is not the correct answer as the third statement only is correct	

Question number	Answer	Additional guidance	Mark
(b)(i)	A calculation showing the following steps: - calculation of cardiac output / min (1) - conversion to dm³ and output per hour and given to two significant figures (1)	$(77 \times 70) = 5390$ $((5390 \times 60) / 1000) = 320$ Correct answer gains 2 marks x60 first and do the x70 afterwards. e.g. 1 mark for 4620 if they don't get the correct answer	(2)

Question number	Answer	Additional guidance	Mark
(b)(ii)	A calculation showing the following steps: • calculation of cardiac output (1) • correct unit stated (1) • calculation of cardiac index (1)	mp1 for $(1.49 \times 2.8) = 4.2$ /4.17 / 4.172 mp2 for $\text{dm}^3\text{min}^{-1}\text{m}^{-2}$ ACCEPT $\text{dm}^3 \text{ m}^{-2} \text{ min}^{-1}$ ACCEPT dm^3 per min per m^2 Mp3 for $(6.9/1.92) = 3.5$ / 3.49 / 3.489 ACCEPT values / units in working if table is empty (or by formula)	(3)

Question number	Answer	Additional guidance	Mark
(b)(iii)	An answer that includes the following points: Indicative content - description from graphs and experimental data Heart rate: • as the concentration of adrenaline increases, the increase in heart rate increases in both groups • this increase is (slightly) {greater in the older group of people / lower in younger people} • at all concentrations of adrenaline the older group have greater {change/heart rate} / at all concentrations of adrenaline the younger group have smaller {change/heart rate} • but there are no error bars to judge whether or not this difference is significant • due to stated effect of aging on heart - weaker muscle/effect on SAN/lower stroke volume Cardiac index: • as the concentration of adrenaline increases, the increase in cardiac index increases in both groups • the increase is the same at {20 / 40} $\text{ng kg}^{-1} \text{ min}^{-1}$ • at concentrations above 40 $\text{ng kg}^{-1} \text{ min}^{-1}$ the increase is {lower in older people / greater in younger people} • overall the increase cardiac index is {lower for the older people / greater for younger people} • due to lower cardiac output / increased body surface area/lower stroke volume / (accept converse for younger people) • but there are no error bars to judge whether or not this difference is significant		(6)

	Change in blood pressure • blood pressures decrease and then increase in both groups (as adrenaline concentration increases) • a concentration of $20 \text{ ng kg}^{-1} \text{ min}^{-1}$ decreases the blood pressure in both groups • a concentration of {84-120} $\text{ng kg}^{-1} \text{ min}^{-1}$ increases the blood pressure in older people • in older people lower change in blood pressure (in response to higher concentrations of adrenaline) / converse for younger people • due to stated changes of aging on heart muscle/ blood vessels/baroreceptors • no overlap of error bars between older and younger people indicate that these differences are significant (at all concentrations of adrenaline) / the error bars overlap for some concentrations for older people meaning that these differences are not significant / the error bars do not overlap for some concentrations for younger people meaning that these differences are significant Level 1: 1 or 2 graphs commented on changes in heart rate/cardiac index/blood pressure as concentration of adrenalin increases Level 2: 2 or 3 graphs commented on, including details of the effect of adrenaline on older people Level 3: All 3 graphs commented on, including details of the effect of adrenaline on older people and discussion of the significance of the data.	
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Q7.

Question number	Answer	Additional guidance	Mark
(a)	A 1 is the correct answer B not 2 as only the collecting duct is affected by ADH C not 3 as only the collecting duct is affected by ADH D not 4 as only the collecting duct is affected by ADH		(1)

Question number	Answer	Additional guidance	Mark
(b)(i)	ultrafiltration	Accept glomerular ultrafiltration	(1)

Question number	Answer	Additional guidance	Mark
(b)(ii)	microvilli		(1)

Question number	Answer	Additional guidance	Mark
(c)(i)	A calculation that has the following stages: - Correctly calculating the radius - Correctly calculating the cross-sectional area (1)	2.355, accept 2.36 17.43, accept 17.5	(2)

Question number	Answer	Additional guidance	Mark
(c)(ii)	Correct calculation of the difference, must include the correct units (1)	1.97, difference in mm² 0.0197, difference in cm², accept 0.02. Allow ECF from 4(c)(ii)	(1)

Question number	Answer	Additional guidance	Mark
(d)	An answer that includes three of the following points: - proximal tubule has role in selective reabsorption (1) - named relative concentration change by reabsorption (1) - comment on protein channels for reabsorption/ suggested mechanism for reabsorption (1) - named relative concentration change by secretion (1)	e.g. 100% of glucose e.g. 70x increase for urea	(3)

Question number	Answer	Additional guidance	Mark
(e)	A two-step calculation: - Calculation of urine in one hour - Correct total for 24 hours to two s.f.	(0.83 x 60 = 49.8) (Accept 60x24x0.83) 1195.2 for onemark 1.2dm³	Graduate (2)

Q8.

Question number	Answer	Additional guidance	Mark
(a)	• correct magnification (1) • magnification given in correct standard form (1)	$(98 \pm 1 \div 0.00075) = 130\,600$ $1.3 \times 10^5 / 1.31 \times 10^5 / 1.306 \times 10^5$ ACCEPT $97 \div 0.00075 = 1.29 \times 10^5$ $99 \div 0.00075 = 1.32 \times 10^5$ Correct answer scores full marks	(2)

Question number	Answer	Additional guidance	Mark
(b)(i)	C $3 \text{ nmol mg}^{-1} \text{ min}^{-1}$ A, B and D are not correct because the correct answer is $60 \div 20 = 3$		(1)

Question number	Answer	Additional guidance	Mark
(b)(ii)	An explanation that includes four of the following points: Sample 1: (carbon dioxide is produced) because pyruvate can be used (as a substrate) for {aerobic respiration / link reaction} (in mitochondria) (1) Sample 2: - ADP increases rate of (aerobic) respiration (1) - because there is (sufficient) ADP for synthesis of ATP (1) Sample 3: - the pyruvate transport inhibitor stops pyruvate being taken into the {mitochondria/matrix} (1)	ACCEPT pyruvate releases carbon dioxide when forming acetyl CoA ACCEPT ADP increases rate of Krebs cycle ACCEPT ADP is converted to ATP ACCEPT ADP is not limiting ACCEPT the pyruvate transport inhibitor stops pyruvate entering {link reaction / Krebs cycle} ACCEPT pyruvate is not converted into acetyl CoA / acetyl CoA doesn't form (in sample 3)	(4)

Question number	Answer	Additional guidance	Mark
(c)(i)	An explanation that includes the following points: - slow twitch muscle fibres have more mitochondria (than fast twitch muscle fibres) (1) - because they rely on (ATP from) aerobic respiration (1) (slow twitch fibres have more mitochondria) because oxygen supply is sufficient / more capillaries carrying oxygenated blood / cells contain (more) myoglobin (1)	ACCEPT converse ACCEPT fast twitch relies on (ATP from) {anaerobic respiration / creatine phosphate} ACCEPT converse	(3)

Question number	Answer	Additional guidance	Mark
(c)(ii)	A description that includes the following points: - ATP binds to the myosin head (1) {releasing the myosin head from the actin strand/breaking the cross-bridge} (1) - ATP is hydrolysed (by the myosin head) (1) - providing energy to move the myosin head {back/upright} (1)	ACCEPT ATP broken down into ADP ACCEPT change shape of myosin head / return to original position Do not accept the power stroke	(4)

Q9.

Question number	Answer	Additional guidance	Mark
(a)	A description that includes four of the following points: • Chemoreceptors detect {pH of blood / blood CO₂ concentration} (1) • send (fewer) impulses to the {respiratory centre / ventilation centre / medulla} (1) • decreased frequency of impulses to {intercostal muscles/diaphragm} (1) • allowing (breathing muscles) to {relax / contract less frequently} (1) • rate set by the {respiratory centre / ventilation centre / medulla / pons} (1) OR • As air enters the lungs, stretch receptors in the lungs are activated (1) • Send impulses to inhibit inspiratory centre (1)	Do not accept message / signal ACCEPT impulses sent via parasympathetic nervous system	(4)

	• (resulting in) {no/fewer} impulses to {intercostal muscles/diaphragm} (1) • allowing (breathing muscles) to {relax / contract less frequently} (1) • rate set by the {inspiratory centre / expiratory centre / medulla / pons} (1)	ignore ventilation centre	
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Question number	Answer	Additional guidance	Mark
(b)	An explanation that includes three of the following points: - receptors on post-synaptic membrane (1) (receptors) have (different) three-dimensional shapes/ are specific for (different) neurotransmitters (1) - description of response once the neurotransmitter has bound to the receptor (1)	ACCEPT {ion channel / gates} on post-synaptic membrane ACCEPT (receptors have) complementary shape to specific neurotransmitter e.g. opening of sodium channels / causing an action potential / depolarising membrane / inhibitory neurotransmitter prevents {depolarisation / action potential}	(3)

Question number	Answer	Additional guidance	Mark
(c)	An answer that includes two of the following points: - release neurotransmitters (1) - that act on white blood cells / (stimulate) {spleen/thymus/lymph nodes} (1) - to {release (more/ less) cytokines / release white blood cells into blood / recruit white blood cells from blood} (1)	ACCEPT release of named neurotransmitter e.g. noradrenaline / adrenaline / epinephrine / acetylcholine ignore release of chemicals ACCEPT release (more/ less) of named chemical e.g. histamine	(2)

Question number	Answer	Additional guidance	Mark
(d)	An explanation that includes the following points: - record ECG before and (for 10 minutes) after changing {posture / position} (1) - count the number of a named peaks in one minute (1) - description of how POTS is identified (1)	ACCEPT calculate heart rate e.g. {heart rate / peaks per minute} will increase by 30 bpm / heart rate will be above 120 bpm (within 10 minutes of posture change)	(2)

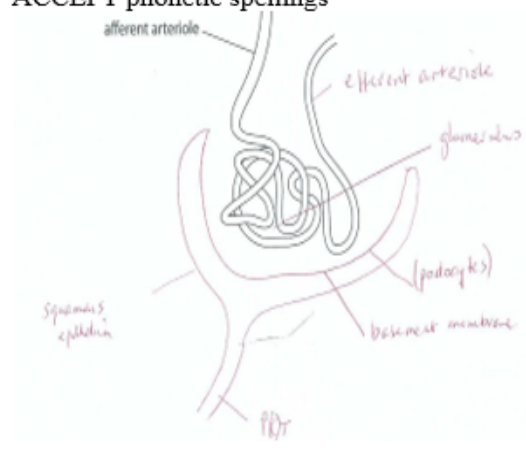
Question number	Answer	Additional guidance	Mark
(e)	An explanation that includes four of the following points: - bolus acts as a stimulus/ receptor detects bolus (1) - motor neurone transmits (electrical) impulse to (smooth) muscle (1) - detail of how nerve impulse stimulates muscle contraction (1) - therefore {circular muscle contracts / longitudinal muscles relax} {around/above} bolus (1) - therefore {circular muscle relax / longitudinal muscles constrict} in {front/below} of bolus (1)	ACCEPT description of food stretching gut wall ACCEPT release of neurotransmitter ACCEPT {circular muscle contracts / longitudinal muscles relax} in {propulsive / proximal} segment ACCEPT {circular muscle relax / longitudinal muscles constrict} in receiving segment	(4)

Question number	Answer	Additional guidance	Mark
(f)	inadequate blood supply to a {tissue / organ} (1)	ACCEPT a named organ e.g. heart ACCEPT {inadequate / decreased / no} blood supply	(1)

Question number	Answer	Additional guidance	Mark
(g)	An answer that includes one of the following points: • mutation (in gene expressed by embryological ENS) (1) • (embryological ENS) do not have surface {antigens/ receptors} that allow them to locate to bowel (1)	ACCEPT so embryological ENS do not differentiate (into working neurones) ACCEPT conditions in the bowel may not be suitable for the growth of the embryonic cells	(1)

Question number	Answer	Additional guidance	Mark
(h)	An explanation that includes three of the following points: • environmental factor changes conditions in the gut / causes a change in the gut flora (1) • therefore microbial {chemicals/toxins} released (1) • (chemicals / toxins / microbes) stimulate an {inflammatory response / immune response} (1) • explanation of how the inflammatory response occurs (1)	ACCEPT new microorganism / pathogen / microbe / bacteria ACCEPT release of {histamine / cytokines} e.g effect of histamine such as vasodilation / oedema occurs / recruitment of inflammatory cells / recruitment of white blood cells	(3)

Q10.

Question number	Answer	Additional guidance	Mark
(a)(i)	• correct shape given (1) • one correct labelled feature (1) • second correctly labelled structure (1)	cup shaped around glomerulus doesn't need to completely envelop / must have PCT possible labels: efferent arteriole glomerulus PCT proximal (convoluted) tubule/ tube podocytes basement membrane squamous epithelium ACCEPT phonetic spellings  The diagram is a hand-drawn sketch of a nephron. It shows a central glomerulus (a cluster of capillaries) surrounded by a cup-shaped Bowman's capsule. Labels with lines pointing to the structures include: 'afferent arteriole' (entering the glomerulus), 'efferent arteriole' (exiting the glomerulus), 'glomerulus', 'PCT' (proximal convoluted tubule, shown as a coiled tube), 'podocytes' (cells surrounding the glomerulus), 'basement membrane' (the layer between the podocytes and the glomerulus), and 'squamous epithelium' (the lining of the Bowman's capsule).	(3)

	Answer	Mark
(a)(ii)	The correct answer is B • A is not the correct answer because amylose is not found in blood • C is not the correct answer because haemoglobin is too big a molecule to be filtered • D is not the correct answer because prothrombin is too big a molecule to be filtered	(1)

	Answer	Mark
(a)(iii)	The correct answer is D • A is not the correct pathway • B is not the correct pathway • C is not the correct pathway	(1)

Question number	Answer	Additional guidance	Mark
(b)	A description that includes the following points: • occurs in proximal (convoluted) tubule (1) • using {transport molecules / transporters/ active transport} (in the membrane of the nephron) (1) • (co transport) with sodium ions (1) • diffuse into blood (capillaries) {down /along} concentration gradient (1)	ACCEPT channel proteins / carrier proteins ignore ref to sodium pump ACCEPT facilitated diffusion	(3)

Question number	Answer	Additional guidance	Mark
(c)	The correct answer is C • A is not the correct answer • B is not the correct answer • D is not the correct answer		(1)

Q11.

Question number	Answer	Additional guidance	Mark
(a)(i)	Choose an item. D sensory neurone is correct A is not correct because a motor neurone does not continue a reflex action after the receptor. B is not correct because the relay neurone does not continue a reflex action after the receptor. C is not correct because a Schwann cell does not continue a reflex action after the receptor.		(1)

Question number	Answer	Additional guidance	Mark
(a)(ii)	Choose an item. C is the correct answer receptor → spinal cord → muscle B is not correct because muscle → receptor → brain is not the correct pathway C is not correct because muscle → spinal cord → brain is not the correct pathway D is not correct because spinal cord → brain → Muscle is not the correct pathway.		(1)

Question number	Answer	Additional guidance	Mark
(b)(i)	A description that includes three of the following points: - reference to use of sodium potassium pump (1) - the sodium ion channels are closed - the membrane is relatively permeable to potassium ions (1) - at rest high potassium ions (K^+) inside the axon, high sodium ions (Na^+) outside axon	Potassium channels open	(3)

Question number	Answer	Additional guidance	Mark
(b)(ii)	An answer that includes the following points: - pressure deforms cell membranes in the Pacinian corpuscle - an influx of sodium ions into the axon - details of the (action potential in the axon)	Accept disrupts, changes cell membrane Do not accept damages If they refer to opening the sodium channels it could be an alternative to second point	(3)

Question number	Answer	Additional guidance	Mark
(b)(iii)	An answer that includes three of the following points: - the threshold (potential) has been reached - results in action potential - action potentials are all or nothing (1)	Accept since either they occur fully or they do not occur at all	(3)

Q12.

Question number	Answer	Additional guidance	
(a)	A description that includes two of the following points: - calcium ions bind to troponin (1) - causing tropomyosin to move (1) - allowing the myosin (head) to bind (1)	ACCEPT change in shape ACCEPT exposing the myosin binding site /allowing actomyosin bridges to form	(2)

Question number	Answer	Additional guidance	
(b)	An explanation that includes the following points: • many mitochondria allows more (aerobic) respiration(1) • many myoglobin molecules allows greater (store) of oxygen (1) • larger capillary network ensures good supply of {oxygen/ glucose} (1) • slow sustained contraction allows longer periods of exercise / race for longer(1)	ACCEPT more ATP produced ACCEPT in context endurance events / decrease in {fatigue / tiredness}	(4)

Question number	Answer	Additional guidance	Mark
(c)	An answer that includes the following points: • exercise increases the rate of heat loss (1) • (eventually) the rate of heat loss reaches its maximum (1)	ACCEPT the rate of heat loss levels off	(2)

Q13.

Question number	Answer	Additional guidance	Mark
(a)	A calculation showing the following steps: - identification of heart rate at 5 and 12.5 minutes for drug B (1) - calculation of percentage change for drug B - correct answer	accept calculation of percentage decrease HR at 5 = 30/31 HR at 12.5 = 57/57.5/58 57-30/30 x100 = 57.5-30/30 x100= 57-31/31 x100= 58-30/30 x100= 58-31/31 x 100= 90.0/91.67/83.87/93.3/87.09 Correct answers gain all 3 marks	3

Question number	Answer	Additional guidance	Mark
(b)	An answer that includes three of the following points: Similarity - both drugs have an effect on the heart rate over the time period (1) - with both the greatest effect in first 3 minutes (1) Difference - change in heart rate with drug A levels off (between 7-10 mins) drug B still increasing at 15 mins (1) - drug B reduces heart rate more than drug A	do not piece together accept increase drug B has greater effect than drug A	3

Question number	Answer	Additional guidance	Mark
(c)	An answer that includes three of the following points: - stress increases heart rate (1) - because cardiovascular centre stimulates the SAN (1) (both) drugs decrease frequency of impulses from SAN (1) - inhibiting the (change/ increase) in heart rate (1) - drug B has a greater effect (on the SAN)(1)	accept converse	3

Question number	Answer	Additional guidance	
(a)	A calculation showing the following step: - width mm/length mm (1) - x actual length mm (1)	$(24.5/75) = 0.33$ $(0.33 \times 2000) = 653$ accept 24/25 as width 75/76/77 as length range 619 - 667	(2)

Question number	Answer	Additional guidance	
(b)	A description that includes three of the following points: - reference to chemiosmosis (1) - electrons passed between (electron carriers / electron acceptors) releasing energy (1) - energy used to move protons (out of matrix) into inter membranal space (1) - role of stalked particle in generation of ATP from ADP and Pi (1)	electrons passed along ETC correct reference to ATP synthase in generation of ATP	(3)

Question number	Answer	Additional guidance	
(c)	A description that includes two of the following points: - hydrolysis of {ATP / bonds}(1) - releases energy (1)		(2)

Q15.

Question number	Answer	Additional guidance	Mark
(a)	An answer showing the following steps: - correct figures taken from graph (1) - correct calculation of percentage change (for fit person) (1) - correct difference given to an appropriate number of decimal places (1)	$170 - 90$ ACCEPT 80 $((170 - 90) \div 170) \times 100 = 47.06 \%$ $47.06 - 16 = 31.06 \%$ Final answer 31 %ACCEPT 31.1 %	(3)

Question number	Answer	Additional guidance	Mark
(b)	An answer showing the following steps: • value of mx (1) • value of y (1) • correctly rounded to a whole number with units (1)	$(-65 \div 240) \times 300$ $= -81.25$ $= (-65 \div 240 \times 300) + 190 =$ 108.75 109 bpm Accept range 107-111	(3)

Question number	Answer	Additional guidance	Mark
(c)	An explanation that includes three of the following points: • fit person has greater lung capacity (1) • fit person (can produce) a greater cardiac output (1) • more effective gas exchange and transport of oxygen to muscles (1) • therefore more rapid reduction of oxygen debt (1)		(3)

Question number	Answer	Additional guidance	Mark
(d)	A description that includes the following points: • cardiovascular control centre in the medulla oblongata (1) • detects change in blood pH (following exercise) (1) • as blood pH increases (more) impulse are sent via the parasympathetic nerve (1) • slowing (the rate of impulses from) the SAN (1)	Accept increase in lactate / CO_2 Accept vagus nerve	(4)

Q16.

Question number	Answer	Mark
(a)	B inner mitochondrial membrane	(1)

Question number	Answer	Mark
(b)(i)	An explanation that includes any two of the following points: • no ATP will be produced by the electron transport chain (1) • because electrons will not be passed onto the oxygen (1) • therefore {reduced NAD will not be reoxidised / the electron transport chain will stop} (1)	(2)

Question number	Answer	Mark
(b)(ii)	An explanation that includes the following points: • there will be no ATP production from reduced NAD (1) • there will be some ATP produced from reduced FAD because electrons from reduced FAD enter the electron transport chain after the site of inhibition of rotenone (1)	(2)

Question number	Answer	Mark
(b)(iii)	An explanation that includes the following points: • because the inhibitors affect the ETC, which is not used in anaerobic respiration (1) • therefore the same quantity of ATP will be produced from substrate level phosphorylation in glycolysis (1)	(2)

Q17.

Question number	Answer	Additional guidance	Mark
(a)	An answer that includes two of the following points: • positive feedback results in an increase in the change (of the variable) (1) • negative feedback results in a decrease in the change (of the variable) (1)	can be phrased in many ways eg. change from normal	2

Question number	Answer	Additional guidance	Mark
(b)	The only correct answer is D <i>A is not the correct answer as thermoregulation is continually required.</i> <i>B is not the correct answer as the body continually generates heat</i> <i>C is not the correct answer as more heat being gained than lost means body is not in equilibrium.</i>		1

Question number	Answer	Additional guidance	Mark
(c)(i)	An explanation that includes the following points: - creatinine is a small molecule (1) - therefore can be forced through the {pores / basement membrane} (1) - as a result of high pressure in the glomerulus (1)	ACCEPT ultrafiltration occurs for mp1 / ignore any RMM figures allow through fenestrations	3

Question number	Answer	Additional guidance	Mark
(c)(ii)	A calculation showing the following step: correct answer given to 3 significant figures (1)	accept $1960/15 \times 60 = 2.18 \text{ mg min}^{-1}$ $1960/15 = 131$	1

Question number	Answer	Additional guidance	Mark
(d)(i)	An answer that includes three of the following points: - general comment about all patients after surgery - comment on difference in 2 groups – can use figures - comment using SD - comment on largest change after surgery	ACCEPT ref to error bars	3

Question number	Answer	Additional guidance	Mark
(d)(ii)	A calculation showing the following steps: - calculation of difference surgery makes for non-diabetic and type II diabetic (1) - correct number calculated (1)	0.32 0.7 $0.7 - 0.32 = 0.38$ correct answer gains 2 marks	2

Q18.

Question number	Answer	Additional guidance	Mark
(a)(i)	A cortex		Computer (1)

Question number	Answer	Additional guidance	Mark
(a)(ii)	A W		Computer (1)

Question number	Answer	Additional guidance	Mark
(a)(iii)	C Y only		Computer (1)

Question number	Answer	Additional guidance	Mark
(b)	An answer that includes the following points: • (urea) forced out by high pressure (of the blood) (1) • caused by afferent blood vessel greater diameter than efferent blood vessel in the glomerulus (1) • through pores in the (basement) membrane (1)	IGNORE any other mechanism other than ultrafiltration ALLOW arteriole NOT artery ALLOW reference to podocytes /glomerular fenestrations	Expert (2)

Question number	Answer	Additional guidance	Mark
(c)	An explanation that includes the following points: • less water available in deserts (1) • (Kangaroo rat conserves water) by producing more concentrated urine (1) • needs to actively transport more sodium ions into (the extracellular fluid of) medulla (1) • therefore needs more mitochondria to produce more ATP (1)	ALLOW Less water available for kangaroo rat ALLOW {more water reabsorbed / filtered out} producing more concentrated urine IGNORE sodium	Expert (3)

Q19.

Question number	Answer	Additional guidance	Mark
(a)(i)	An answer that includes the following point - B is the correct answer - A is not the correct answer - C is not the correct answer - D is not the correct answer		(1)

Question number	Answer	Additional guidance	Mark
(a)(ii)	An answer that includes the following point: - B is the correct answer - A is not the correct pathway - C is not the correct pathway - D is not the correct pathway		(1)

Question number	Answer	Additional guidance	Mark
(b)(i)	An answer that includes three of the following points: - heart rate decreases when diving (1) - the longer the whale is diving the lower the heart rate (1) - the difference between maximum heart rate at the surface and minimum heart rate in dive increases as dive duration increases (1)	accept ref to max and min HR	(3)

Question number	Answer	Additional guidance	Mark
(b)(ii)	An answer that includes three of the following points: - relevant physiological change during a dive described (1) {pH/oxygen / carbon dioxide concentrations} in the blood monitored by {chemoreceptors / sensors} (1) - increase in impulses from medulla to SAN (1) - increase impulses from SAN leading to increased heart rate (1)	E.g. blood oxygen decreases / {CO ₂ /lactate} increases / pH decreases / oxygen debt develops accept increased depolarisations	(3)

Q20.

Question number	Answer	Additional guidance	Mark
(a)(i)	An answer that includes the following point: B is the correct answer • A is not the correct answer as adrenal glands do not produce ADH • C is not the correct answer as the medulla oblongata does not produce ADH • D is not the correct answer as the pituitary gland does not produce ADH		(1)

Question number	Answer	Additional guidance	Mark
(a)(ii)	An answer that includes the following point: B is the correct answer • A is not the correct answer as ADH does not act on the capillaries • C is not the correct answer as ADH does not act on the proximal tubules • D is not the correct answer as ADH does not act on the ureters		(1)

Question number	Answer	Additional guidance	Mark
(a)(iii)	An answer that includes the following point: C is the correct answer • A is not the correct answer as the countercurrent multiplier does not control plasma volume • B is not the correct answer as habituation is a behavioural response • D is not the correct answer as control of plasma volume is not a positive feedback		(1)

Question number	Answer	Additional guidance	Mark
(a)(iv)	• osmoreceptors	ACCEPT osmotic receptor	(1)

Question number	Answer	Additional guidance	Mark
(b)(i)	An answer that includes the following points: • increasing concentration of the gibberellin increases {length / growth} (of all internodes) (1) • increase is mostly in the length of the first internode (1)	ACCEPT positive correlation ignore gibberellin increases plant growth unqualified ACCEPT {least / smallest} effect on the last/3rd internode	(2)

Question number	Answer	Additional guidance	Mark
(b)(ii)	An answer that includes three of the following points: • gibberellin {enters the nucleus / binds to cell surface receptors} (1) • gibberellin {acts as a transcription factor / activates transcription factor} (1) • effect of transcription factor (1) • (causing) cell elongation / cell division (and causes internode elongation) (1)	ACCEPT secondary messenger e.g. activates protein synthesis / stimulates amylase production / amylase breaking starch down into glucose for respiration	(3)