**Heart, Ventilation and Homeostasis (Topic 7): Edexcel SNAB A Level Biology Exam Questions by Topic**

20 questions · 52 marks · about 62 minutes. Answer in the spaces, then check the mark schemes at the end.

**Question 1 · A level Paper 3 · June 2023 · Q1(b)(i) · 1 mark**

(b) If the heart of an animal is removed from its body, the heart will continue to beat for a period of time.

The left atrium stops contracting if it is separated from the rest of the heart.

However, the right atrium and the rest of the heart will continue to beat.

Eventually, the right atrium and the rest of the heart will also stop beating.

(i) Give a reason why the heart will continue to beat after being removed from the body.

**(1)**

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**Question 2 · A level Paper 3 · June 2023 · Q1(b)(ii) · 2 marks**

(ii) Explain why the left atrium stops beating when it is separated from the right atrium.

**(2)**

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**Question 3 · A level Paper 2 · June 2017 · Q2(b) · 2 marks**

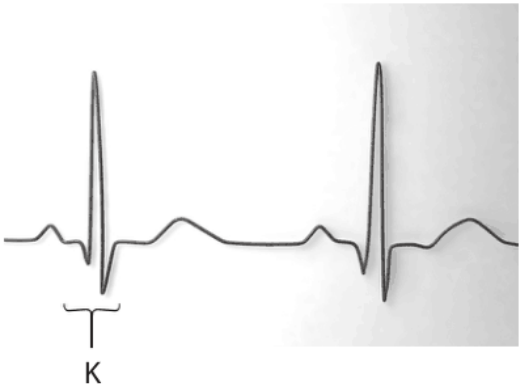
(b) Describe how the sinoatrial node (SAN) is involved in bringing about a change in heart rate as the level of activity increases.

**(2)**


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(b) Electrocardiograms (ECGs) were also recorded for the people with carbon dioxide poisoning.

The diagram shows part of an ECG.




(Source: KATERYNA KON/SCIENCE PHOTO LIBRARY)

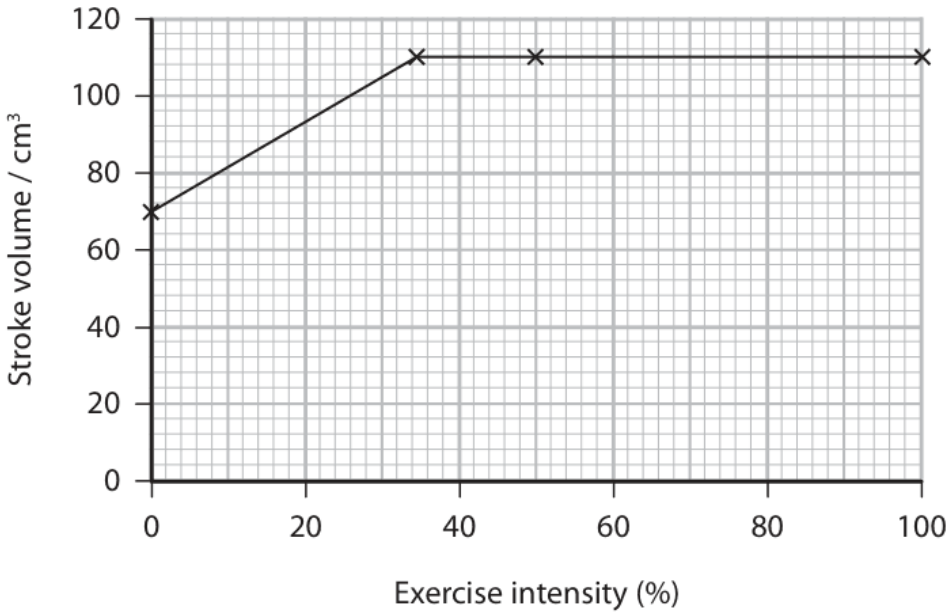
Explain the role of the atrioventricular node (AVN) in the events happening at K on the ECG.

**(3)**


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(c) When running a marathon, both heart rate and stroke volume increase.

The graph shows the effect of exercise intensity on stroke volume for marathon runners.




(i) Cardiac output is the product of stroke volume and heart rate.

During a race, a marathon runner's exercise intensity increased from 0 to 100%. The table shows the effect on the runner's heart rate.

| Exercise intensity (%) | Heart rate / bpm |
|---|---|
| 0 | 55 |
| 100 | 160 |

Calculate the increase in cardiac output for a marathon runner during a race.

Give your answer in $dm^3\,min^{-1}$.

**(2)**

..... $dm^3\,min^{-1}$


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**Question 6 · A level Paper 2 · June 2018 · Q5(c)(ii) · 2 marks**

(ii) Explain why it is necessary for the cardiac output of marathon runners to increase during a race.

**(2)**

**Question 7 · A level Paper 2 · June 2019 · Q4(a)(i) · 2 marks**

**4** A moderate amount of exercise is considered good for the human body.

(a) A student carried out 20 minutes of physical exercise. During this time, her heart rate and level of sweating increased.

Shortly after completing the exercise, the student noted that her heart rate and level of sweating decreased.

(i) Explain the role of the brain in reducing the student's heart rate after the exercise.

**(2)**


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**Question 8 · A level Paper 2 · June 2024 · Q3(a)(i) · 4 marks**

**3** In 2021, there was an accident at a nuclear power station in Spain. There was no radiation leak but carbon dioxide was released.

Some people were taken to hospital showing symptoms of carbon dioxide poisoning after inhaling carbon dioxide.

Their symptoms included rapid breathing and an increased heart rate.

(a) (i) Explain why rapid breathing is a symptom of carbon dioxide poisoning.

**(4)**

**Question 9 · A level Paper 3 · June 2019 · Q3(c) · 3 marks**

(c) At the start of exercise, breathing rate increases.

Explain how starting to exercise causes an increase in breathing rate.

**(3)**


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**3** Doctors sometimes prescribe beta-blockers for their patients.

Beta-blockers are a type of drug with antihypertensive properties.

(a) In one study, the effect of beta-blockers on the heart rate during exercise was investigated.

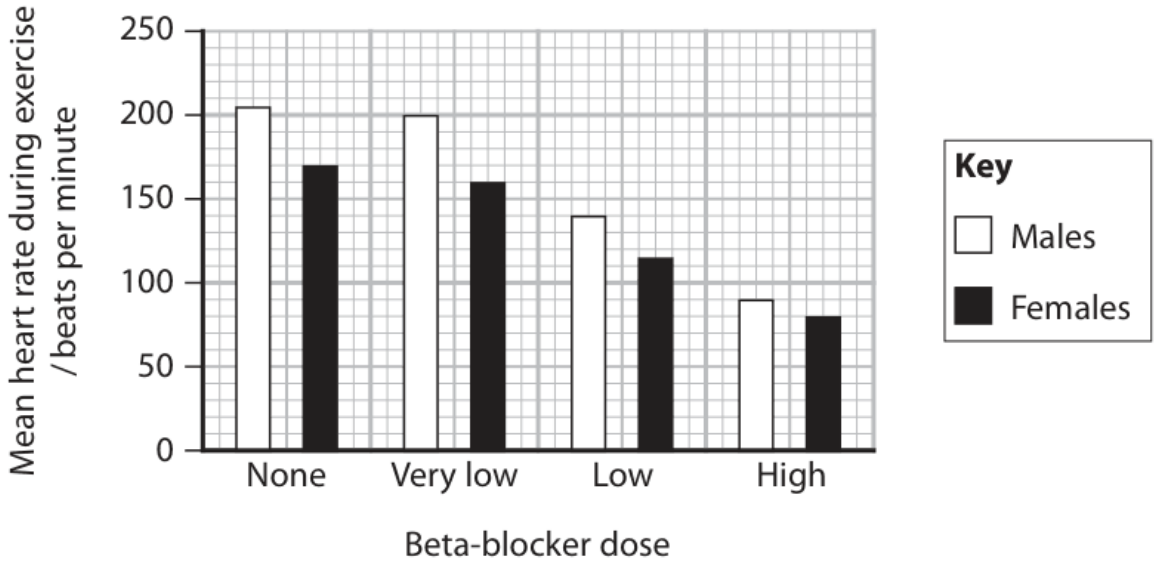
In this study, volunteers were placed randomly into one of four groups shown in the table.

| Group | Dose of beta-blocker |
|---|---|
| A | none |
| B | very low |
| C | low |
| D | high |

The heart rate of each volunteer was recorded during a period of exercise.

A mean value was calculated separately for the males and females in each group.

The graph shows the results of this study.





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**Question 10 · A level Paper 3 · November 2021 · Q3(a)(ii) · 4 marks**

(ii) Deduce the effect of beta-blockers on the supply of blood to muscle during exercise.

**(4)**


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**Question 11 · A level Paper 2 · June 2018 · Q5(a) · 4 marks**

**5** Athletic competitions often take place during the summer months when ambient temperatures are high.

High ambient temperatures affect marathon runners.

Heat stress occurs when the core body temperature rises above 40 °C.

(a) Describe how thermoregulatory mechanisms are controlled to help marathon runners avoid heat stress.

**(4)**


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**Question 12 · A level Paper 2 · June 2019 · Q4(a)(ii) · 2 marks**

(ii) Describe how the brain reduces the activity of the sweat glands after the exercise.

**(2)**


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**7** When scientists visit Antarctica, they need appropriate clothing to help with thermoregulation.

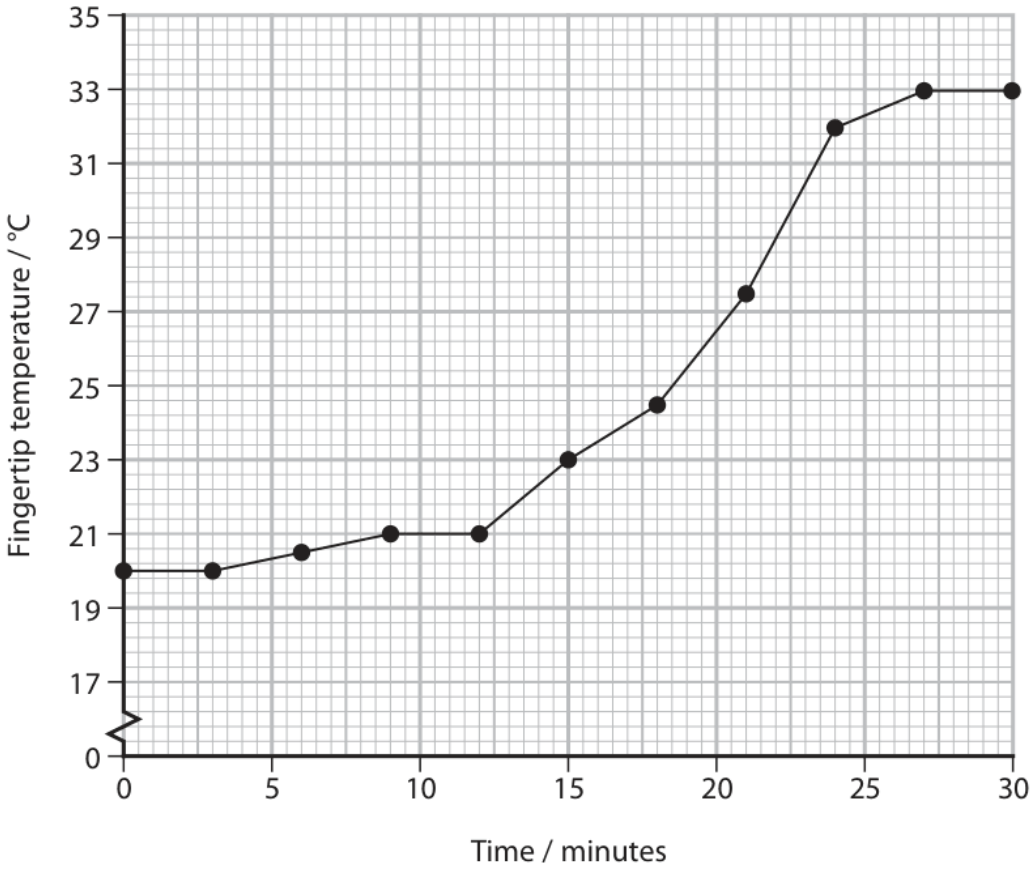


www.aa.com

(a) An investigation was carried out to study thermoregulation in humans.

A woman was wrapped in blankets and her feet were put in hot water for 30 minutes. During this time, the temperature of the skin at the end of one of her fingertips was recorded.

The graph shows the results of this investigation.




(i) Explain why there was no change in fingertip temperature between 0 and 3 minutes.

**(2)**


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**Question 14 · A level Paper 3 · June 2023 · Q4(c) · 4 marks**

(c) Describe how the production of sweat is controlled during exercise in humans.

**(4)**

**Question 15 · information from earlier in the question**

(b) At the start of the investigation, each athlete swallowed a small digital thermometer so their core body temperature could be measured. A mean core temperature was calculated.

The athletes carried out warm-up activities for 20 minutes in a chamber set at 16 °C.

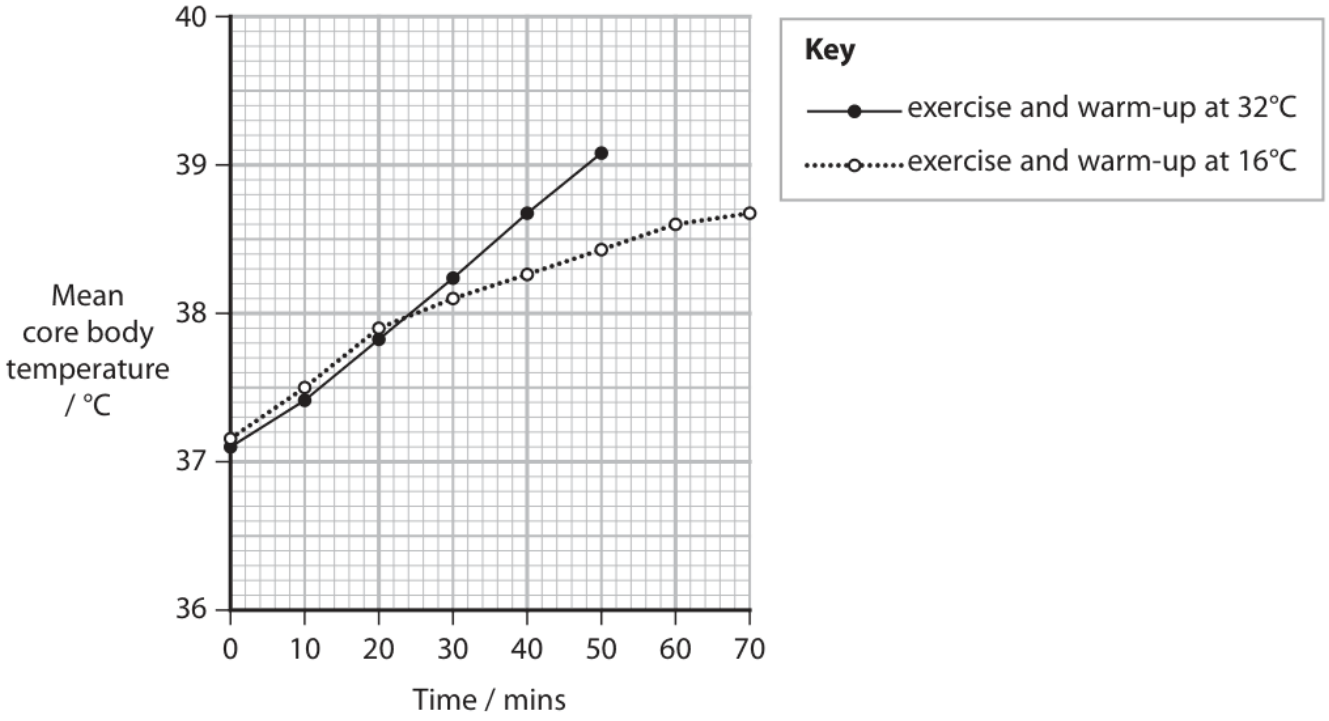
After warming up, each athlete exercised. The intensity of the exercise was increased at three-minute intervals. Each athlete exercised until they were unable to continue.

The change in body mass of each athlete during the warm-up activities and the exercise was recorded. The mean change in mass was calculated and used as a measure of the sweat produced.

The warm-up and exercise were repeated at a temperature of 32 °C.


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(ii) The graph shows the effect of the warm-up activities (from 0–20 minutes) and exercise (from 20 minutes) on mean core body temperature.




Explain the effect of environmental temperature on core body temperature during warm-up activities followed by exercise.

**(3)**


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**Question 16 · A level Paper 2 · June 2019 · Q4(b) · 3 marks**

(b) Explain why too much exercise could be harmful to the human body.

**(3)**

**Question 17 · information from earlier in the question**

(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 |

**Question 17 · A level Paper 2 · June 2022 · Q7(b)(ii) · 1 mark**

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

**(1)**


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**Question 18 · information from earlier in the question**

(c) Keyhole surgery or open surgery can be used to treat ACL damage.

A study compared wound infections from these two types of surgery.

The table shows the results of this study.

| Type of surgery | Number of surgeries | Number of wound infections after surgery | Ratio of wound infections to number of surgeries |
|---|---|---|---|
| Keyhole surgery | 2623 | 2 | 0.0008 : 1 |
| Open surgery | 13 472 | 68 | |

**Question 18 · A level Paper 2 · June 2023 · Q3(c)(ii) · 2 marks**

(ii) Explain why there is a greater ratio of wound infections in open surgery compared with keyhole surgery.

**(2)**

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**Question 19 · A level Paper 2 · June 2018 · Q1(b) · 3 marks**

(b) Beta cells in the pancreas produce insulin when there is an increase in glucose levels in the blood.

Transcription factors are involved in the activation of the insulin gene.

Explain how transcription factors could activate insulin gene expression in beta cells.

**(3)**

**Question 20 · information from earlier in the question**

**2** Acetylcholinesterase is an enzyme involved in regulating the transmission of nerve impulses across some synapses.

(a) Acetylcholinesterase is found on the cell surface membranes of neurones and red blood cells.

These acetylcholinesterase molecules have different primary structures.

In humans, a single gene codes for acetylcholinesterase.


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**Question 20 · A level Paper 3 · November 2021 · Q2(a)(ii) · 3 marks**

(ii) Explain how the acetylcholinesterase gene can be expressed in some tissues but not others.

**(3)**


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## Mark schemes

**Question 1 · A level Paper 3 · June 2023 · Q1(b)(i) · 1 mark**

| Question number | Answer |
|---|---|
| 1(b)(i) | An answer that makes reference to the following:<br>• (heart / cardiac muscle) is myogenic (1) |

| Additional guidance | Mark |
|---|---|
| IGNORE references to impulses / electrical signals | (1) |

**Question 2 · A level Paper 3 · June 2023 · Q1(b)(ii) · 2 marks**

| Question number | Answer |
|---|---|
| 1(b)(ii) | An explanation that makes reference of the following:<br>• the {pacemaker / SAN / sinoatrial node} is in the right atrium (1)<br>• (left atrium) cannot contract without impulses from the SAN (1) |

| Additional guidance | Mark |
|---|---|
| ALLOW depolarisation is initiated in the right atrium<br>ALLOW no longer attached to the SAN<br><br>ALLOW left atrium does not receive impulses needed to stimulate {contraction / beating} | (2) |


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**Question 3 · A level Paper 2 · June 2017 · Q2(b) · 2 marks**

| Question number | Answer |
|---|---|
| **2(b)** | A description that makes reference to two of the following points:<br>• more { stimulation / depolarisation } of the SAN (from the sympathetic nervous system) / more impulses to the SAN (1)<br>• (causing) more frequent waves of depolarisation from the SAN (to the atria) (1)<br>• leading to more frequent { contraction of atria / stimulation of AVN } (1) |

| Additional guidance | Mark |
|---|---|
| | (2) |


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**Question 4 · A level Paper 2 · June 2024 · Q3(b) · 3 marks**

| Question Number | Answer |
|---|---|
| 3(b) | An explanation that makes reference to three of the following:<br>• K represents { ventricular systole / the QRS complex } (1)<br>• (AVN) picks up electrical activity from atria / allows electrical activity to travel from atria to ventricles (1)<br>• (but) delays transmission of electrical activity from atria / allows time for atria to empty (1)<br>• passes electrical activity to { Purkyne fibres / bundle of His } (1) |

| Additional Guidance | Mark |
|---|---|
| ALLOW depolarisation, electrical impulses, action potentials for electrical activity<br>ALLOW contraction of ventricles<br>ALLOW (AVN) picks up electrical activity from the SAN<br>ALLOW delay gives time for ventricles to fill with blood<br>ALLOW Purkinje fibres | 3 |


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**Question 5 · A level Paper 2 · June 2018 · Q5(c)(i) · 2 marks**

| Question Number | Answer |
|---|---|
| **5(c)(i)** | • correct calculation of both cardiac outputs (1)<br>• correct calculation of difference and converted to $dm^3$ (1) |

| Additional Guidance | Mark |
|---|---|
| <u>Example of calculation</u><br>70 x 55 = 3850 ($cm^3$) / 3.85 ($dm^3$)<br>110 x 160 = 17600 ($cm^3$) /17.6 ($dm^3$)<br>An increase of 13.75 ($dm^3$ $min^{-1}$)<br>Correct answer with no working gains full marks.<br>If correct answer not given<br>ALLOW 13750 for 1 mark<br>Or 13.64 to 13.86 for 1 mark | **(2)** |


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**Question 6 · A level Paper 2 · June 2018 · Q5(c)(ii) · 2 marks**

| Question Number | Answer |
|---|---|
| **5(c)(ii)** | An explanation that makes reference to two of the following:<br>• increase supply of oxygenated blood (to muscles) (1)<br>• to allow aerobic respiration (1)<br>• to provide more energy (to meet the increased demands) (1) |

| Additional Guidance | Mark |
|---|---|
| ALLOW more oxygen (to the muscles) | **(2)** |

**Question 7 · A level Paper 2 · June 2019 · Q4(a)(i) · 2 marks**

| Question Number | Answer |
|---|---|
| **4(a)(i)** | An explanation that makes reference to two of the following:<br>• chemoreceptors detect a change in { carbon dioxide / pH } (1)<br>• the cardiovascular control centre { receives impulses from chemoreceptors / sends impulses to the heart } (1)<br>• (therefore impulses are transmitted) along the parasympathetic { nerve / nervous system / nerve pathway } to the SAN (reducing heart rate) (1) |

| Additional Guidance | Mark |
|---|---|
| ALLOW cardiac control centre<br>ALLOW cardiovascular control centre sends impulses to the SAN<br>ALLOW vagus nerve | **(2)** |


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**Question 8 · A level Paper 2 · June 2024 · Q3(a)(i) · 4 marks**

| Question Number | Answer |
|---|---|
| 3(a)(i) | An explanation that makes reference to four of the following:<br>• raised carbon dioxide (concentration) in blood / reduced blood pH (1)<br>• (that is) detected by chemoreceptors (1)<br>• (resulting in) impulses sent to the { ventilation centre / medulla (oblongata) } (1)<br>• (so) more impulses sent along the motor neurones (to muscles involved in breathing) (1)<br>• (so there is an) increase in rate of { diaphragm / intercostal muscle } contraction (and relaxation) (1) |

| Additional Guidance | Mark |
|---|---|
| ALLOW increased carbonic acid in blood<br>ALLOW inspiratory centre<br>ALLOW more impulses along the phrenic nerve<br>ALLOW increased impulses along sympathetic nerve pathways | 4 |


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**Question 9 · A level Paper 3 · June 2019 · Q3(c) · 3 marks**

| Question Number | Answer |
|---|---|
| 3(c) | An explanation that makes reference to the following:<br>• exercise initiates impulses from the {motor cortex / stretch receptors in muscles / proprioceptors } (1)<br>• (impulses sent to or from the) { ventilation centre / respiratory control centre / medulla oblongata } (1)<br>• leading to increased impulses to { intercostal muscles / diaphragm } (1) |

| Additional guidance | Mark |
|---|---|
| **IGNORE** reference to chemoreceptors and changes in carbon dioxide or temperature receptors | **(3)** |


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**Question 10 · A level Paper 3 · November 2021 · Q3(a)(ii) · 4 marks**

| Question number | Answer |
|---|---|
| 3(a)(ii) | An answer that makes reference to the following:<br>• the larger the dose the greater the decrease in heart rate (1)<br>• reducing the heart rate reduces the cardiac output (1)<br>• therefore, reducing the supply of blood to the muscle (1)<br>• increasing the dose has a greater effect on males than females (1) |

| Additional guidance | Mark |
|---|---|
| ALLOW at very low dose there is little change in heart rate<br>IGNORE oxygen / nutrients / body<br>ALLOW comparison of decrease in males and females e.g. 56% decrease in males and 53% decrease in females | Choose an item<br>(4) |


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**Question 11 · A level Paper 2 · June 2018 · Q5(a) · 4 marks**

| Number | |
|---|---|
| **5(a)** | A description that makes reference to four of the following:<br>• thermoreceptors (in hypothalamus or skin) detect increase in temperature (1)<br>• { heat loss / thermoregulatory } centre in hypothalamus stimulated (1)<br>• (hypothalamus) sends impulses to sweat glands (1)<br>• increased blood flow to surface of skin by {vasodilation / constriction of shunt vessels} (1)<br>• decreased metabolic rate (1) |

| | |
|---|---|
| ALLOW impulses sent to thermoregulatory centre in hypothalamus<br>ALLOW action potential<br>IGNORE dilation of capillaries | **(4)** |

**Question 12 · A level Paper 2 · June 2019 · Q4(a)(ii) · 2 marks**

| Question Number | Answer |
|---|---|
| **4(a)(ii)** | A description that makes reference to the following:<br>• thermoreceptors detect a decrease in temperature (1)<br>• { hypothalamus / thermoregulatory centre } sends fewer impulses to sweat glands (1) |

| Additional Guidance | Mark |
|---|---|
| | **(2)** |


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**Question 13 · A level Paper 2 · October 2020 · Q7(a)(i) · 2 marks**

| Question Number | Answer |
|---|---|
| 7(a)(i) | An explanation that makes reference to two of the following:<br>• time is required for heat to warm the blood (1)<br>• because of the layer of insulation in the skin (1)<br>• because it takes time for the warm blood to circulate (1) |

| Additional Guidance | Mark |
|---|---|
| ALLOW it takes time for warm blood to reach the fingertip | (2) |


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**Question 14 · A level Paper 3 · June 2023 · Q4(c) · 4 marks**

| Question number | Answer |
|---|---|
| 4(c) | A description that makes reference to four of the following:<br>• by {homeostasis / a negative feedback response} (1)<br>• thermoreceptors {in the skin / hypothalamus} detect a rise in temperature (1)<br>• send impulses to the {heat loss centre / thermoregulatory centre / hypothalamus} (1)<br>• {heat loss centre / thermoregulatory centre / hypothalamus} sends impulses to the sweat glands (1)<br>• to increase sweat production (1) |

| Additional guidance | Mark |
|---|---|
| IGNORE description of feedback response<br>ALLOW liver / skeletal muscle<br>IGNORE body<br>ALLOW {heat loss centre / hypothalamus} coordinates motor response to sweat glands<br>ALLOW to release of sweat | (4) |


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**Question 15 · A level Paper 2 · June 2024 · Q10(b)(ii) · 3 marks**

| Question Number | Answer |
|---|---|
| 10(b)(ii) | An explanation that makes reference to three of the following:<br>• both increase the same during warm-up due to doing same {warm-up / level of exercise } / environmental temperature had little effect during warm-up (1)<br>• increase in core body temperature during { warm-up / exercise } due to { respiration / muscle contraction } (1)<br>• during exercise core body temperature increased to a higher level at 32°C than at 16°C (1)<br>• (because) less heat lost at higher environmental temperature (1) |

| Additional Guidance | Mark |
|---|---|
| ALLOW converse<br>e.g. 39.1°C and 38.4°C at 50 minutes<br>ALLOW converse<br>ALLOW reference to thermoregulatory mechanism | 3 |


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**Question 16 · A level Paper 2 · June 2019 · Q4(b) · 3 marks**

| Question Number | Answer |
|---|---|
| 4(b) | An explanation that makes reference to three of the following:<br>• (increased exercise results in) wear (and tear) of { joints / cartilage / tendons / ligaments } (1)<br>• (therefore leading to) joint damage (1)<br>• suppression of immune system (1)<br>• (therefore leading to) increased risk of infection (1) |

| Additional Guidance | Mark |
|---|---|
| e.g. arthritis or a named injury<br>e.g. reduced { T cell numbers / antibody production }<br>e.g. appropriate infection such as upper respiratory tract infections, cold, influenza | (3) |

**Question 17 · A level Paper 2 · June 2022 · Q7(b)(ii) · 1 mark**

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| 7(b)(ii) | • there are fewer neutrophils and the activity is reduced | | (1) |


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**Question 18 · A level Paper 2 · June 2023 · Q3(c)(ii) · 2 marks**

| Question Number | Answer |
|---|---|
| 3 (c)(ii) | An explanation that makes reference to the following:<br>• larger opening / slower recovery time (1)<br>• access for (more) {pathogens / bacteria} / (therefore) more time for { pathogen entry / bacteria entry / infection } |

| Additional Guidance | Mark |
|---|---|
| ALLOW converse for keyhole surgery<br>ALLOW converse for keyhole surgery | [2] |


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**Question 19 · A level Paper 2 · June 2018 · Q1(b) · 3 marks**

| Question Number | Answer |
|---|---|
| **1(b)** | An explanation that makes reference to the following:<br>• interaction between transcription factors and promoter (region on gene) (1)<br>• RNA polymerase binds (to promoter region) (1)<br>• { transcription /mRNA produced } (for insulin gene) (1) |

| Additional Guidance | Mark |
|---|---|
| ALLOW 'regulatory' instead of 'promoter' or reference to transcription initiation complex<br>ALLOW transcription initiation complex binds (to promoter region) if RNA polymerase described as part of the complex | **(3)** |


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**Question 20 · A level Paper 3 · November 2021 · Q2(a)(ii) · 3 marks**

| Question number | Answer |
|---|---|
| 2(a)(ii) | An explanation that makes reference to three of the following:<br>• {hormones / signal molecules / chemical signals} bind to receptors found only in some {tissues / cells} (1)<br>• regulating a {transcription factor / repressor molecules} (1)<br>• {transcription factor / repressor molecule} binds to the promotor region of the (acetylcholinesterase) gene (1)<br>• therefore switching {on / off} transcription (1) |

| Additional guidance | Mark |
|---|---|
| ALLOW epigenetic changes occur in some tissues<br>ALLOW only act on some {tissues / cells}<br>ALLOW {allowing / preventing} binding of RNA polymerase | Choose a item.<br>(3) |


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