(ii) Explain how the respiratory centre is involved in the control of ventilation rate in the 10 minutes of rest after exercise.

(5)

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

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

(3)

0 1 . 1 Exercise causes an increase in heart rate.

Describe the role of receptors and of the nervous system in this process.

[4 marks]

1 0 . 2 During hibernation, the heart rate and the metabolic rate of black bears decrease (lines 3–5).

Use your knowledge of the nervous control of heart rate to describe how these are linked.

[4 marks]

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

(2)

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(b) The student wrote the following summary about the control of heart rate.

When the heart rate is too low the level of carboxylic acid in the blood becomes higher than normal. The vagus nerve sends action potentials to the AVN to increase the contraction rate of the heart muscle. The baroreceptors in the walls of the blood vessels then detect that the pH of the blood is normal, so heart rate can return to resting.

The endocrine system can also change heart rate. Release of the hormone adrenaline from the adrenal medulla causes the smooth muscle of the heart to contract more frequently.

Identify **and** correct any biological errors in the student's summary.

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[4]

(b) Outline the **hormonal** and **nervous** mechanisms involved in the control of heart rate.

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

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..... **[5]**

(ii) Explain how the respiratory centre is involved in the control of ventilation rate in the 10 minutes of rest after exercise.

(5)

An explanation that makes reference to five of the following:

1. High CO2 in the blood stimulates the respiratory centre (1)
2. Increase in lactate / fall in pH stimulates the respiratory centre (1)
3. Reference to chemoreceptors in the medulla/carotid bodies/aortic bodies (1)
4. More impulses sent to diaphragm and intercostal muscles (1)
5. Resulting in an increase in the rate and depth of breathing (1)
6. pH returns to normal as CO2 is removed and ventilation rate decreases (1)

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

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

(3)

1. exercise initiates impulses from the {motor cortex / stretch receptors in muscles / proprioceptors } (1)
2. (impulses sent to or from the) { ventilation centre / respiratory control centre / medulla oblongata } (1)
3. leading to increased impulses to { intercostal muscles / diaphragm } (1)

1. IGNORE reference to chemoreceptors and changes in carbon dioxide or temperature receptors

0 1 . 1 Exercise causes an increase in heart rate.

Describe the role of receptors and of the nervous system in this process.

[4 marks]

1. Chemoreceptors detect rise in CO_2/H^+/acidity/carbonic acid/fall in pH
OR
Baro/pressure receptors detect rise in blood pressure;
2. Send impulses to cardiac centre/medulla;
3. More impulses to SAN;
4. By sympathetic (nervous system for chemoreceptors/CO_2)
OR
By parasympathetic (nervous system for baro/pressure receptors/blood pressure);

1. Ignore: location of receptors.
1. Ignore: chemoreceptors detect oxygen.
2 and 3. Accept: action potentials.
2. Reject: 'messages', 'signals', 'an impulse' or an 'action potential'.
3. Ignore: messages', 'signals', 'an impulse' or an 'action potential' as emphasis here is on increase in frequency.

1 0 . 2 During hibernation, the heart rate and the metabolic rate of black bears decrease (lines 3–5).

Use your knowledge of the nervous control of heart rate to describe how these are linked.

4 max **[4 marks]**

1. (Lower metabolism so) less/low CO_2 (in blood);
2. (Detected by) chemoreceptors;
3. (Chemoreceptors) located in aorta/medulla
   OR
   (Chemoreceptors) located in carotid artery;
4. Fewer impulses to cardiac centre;
   OR
   Fewer impulses to medulla (oblongata);
5. (More) impulses along parasympathetic/vagus pathway/neurones/nerve
   OR
   Fewer impulses along sympathetic pathway/neurones/nerve;
6. (To) SAN;

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)

1. chemoreceptors detect a change in { carbon dioxide / pH } (1)
2. the cardiovascular control centre { receives impulses from chemoreceptors / sends impulses to the heart } (1)
3. (therefore impulses are transmitted) along the parasympathetic { nerve / nervous system / nerve pathway } to the SAN (reducing heart rate) (1)

2. ALLOW cardiac control centre
   ALLOW cardiovascular control centre sends impulses to the SAN
3. ALLOW vagus nerve

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

(2)

- thermoreceptors detect a decrease in temperature (1)
- { hypothalamus / thermoregulatory centre } sends fewer impulses to sweat glands (1)

(b) The student wrote the following summary about the control of heart rate.

When the heart rate is too low the level of carboxylic acid in the blood becomes higher than normal. The vagus nerve sends action potentials to the AVN to increase the contraction rate of the heart muscle. The baroreceptors in the walls of the blood vessels then detect that the pH of the blood is normal, so heart rate can return to resting.

The endocrine system can also change heart rate. Release of the hormone adrenaline from the adrenal medulla causes the smooth muscle of the heart to contract more frequently.

Identify **and** correct any biological errors in the student's summary.

1 carboxylic acid should be carbonic acid / H_2CO_3 ✓
2 vagus (nerve) should be , accelerator / sympathetic / accelerans , (nerve)✓
3 AVN should be , SAN / sinoatrial node ✓

4 baroreceptors should be chemoreceptors
OR
pH should be pressure✓
5 smooth muscle should be cardiac muscle ✓

Error and correct term must be clearly identified.
ALLOW copied statements where correct terms replace errors.

1 IGNORE carbon dioxide
5 ALLOW specialised striated

[4]

Question	Expected Answers	Marks	Additional Guidance
5 (b)	1 **adrenalin(e)** increases , heart rate / stroke volume / cardiac output ;	4 max	1
	2 **cardiovascular centre** in **medulla oblongata** ;		2 **ACCEPT** 'cardiac' instead of cardiovascular but not for QWC
	3 *idea of* nervous connection to , SAN / **sino-atrial node** ;		3 **ACCEPT** SAN for mp 3 but not for QWC
	4 (which) controls frequency of waves of , excitation / depolarisation ;		4 **CREDIT** in relation to mp 2 or mp 3
	5 **vagus** / **parasympathetic** , nerve decreases heart rate ;		5 **ONLY CREDIT** vagus ***or*** parasympathetic for QWC
	6 **accelerator** / **sympathetic** , nerve increases heart rate ;		6 **ONLY CREDIT** accelerator ***or*** sympathetic for QWC **ACCEPT** phrenic nerve
	7 high blood pressure detected by , stretch receptors / baroreceptors ;		7 **DO NOT CREDIT** proprioreceptor
	8 low blood pH / increased levels of blood CO_2 , detected by **chemoreceptors** ;		8
	9 (receptors) in , aorta / **carotid** sinus / carotid arteries ;		9
	QWC – technical terms used appropriately with correct spelling ;	1	Correct use of **adrenalin(e)** (**Identify using the tick 1** ✓1 AND MUST BE INCLUDED FOR QWC TO BE AWARDED) **plus** use of **2** terms from: **cardiovascular centre, medulla oblongata, sino-atrial node, vagus or parasympathetic, carotid, accelerator or sympathetic, chemoreceptor** **You should use the GREEN DOT to identify the remaining QWC terms that you are crediting.** **Please insert a QWC symbol next to the PENCIL ICON, followed by a tick (✓) if QWC has been awarded or a cross (✗) if QWC has not been awarded**
	TOTAL	**10**	