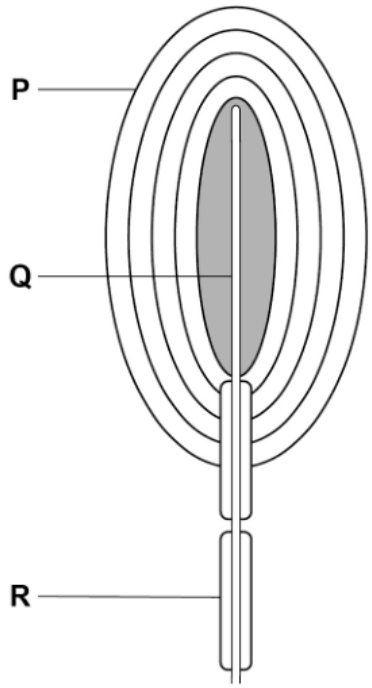
# Receptors and Control of Heart Rate: AQA A Level Biology Exam Questio

14 questions · 43 marks · about 56 minutes. Answer in the spaces, then check the mark schemes at the end.

**Question 1 · A level Paper 3 · June 2022 · Q02.1 · 2 marks**

**0 2** **Figure 4** shows a diagram of a Pacinian corpuscle.

**Figure 4**




**0 2 . 1** Name the structures labelled **P**, **Q** and **R** shown in **Figure 4**.

**[2 marks]**

**P** _____

**Q** _____

**R** _____


Questions, mark schemes and examiners' report extracts © AQA.

**Question 2 · A level Paper 3 · June 2023 · Q01.1 · 3 marks**

**0 1 . 1** Describe how stimulation of a Pacinian corpuscle produces a generator potential.

**[3 marks]**

**Question 3 · A level Paper 2 · November 2020 · Q01.2 · 3 marks**

**0 1 . 2** The fovea of the eye of an eagle has a high density of cones. An eagle focuses the image of its prey onto the fovea.

Explain how the fovea enables an eagle to see its prey in detail.

Do **not** refer to colour vision in your answer.

**[3 marks]**


Questions, mark schemes and examiners' report extracts © AQA.

**Question 4 · A level Paper 2 · November 2020 · Q01.4 · 3 marks**

**0 1 . 4** The retina of an owl has a high density of rod cells.

Explain how this enables an owl to hunt its prey at night.

Do **not** refer to rhodopsin in your answer.

**[3 marks]**


Questions, mark schemes and examiners' report extracts © AQA.

**1 0** Read the following passage.

Complete achromatopsia is a form of complete colour blindness. It is caused by having only rods and no functional cone cells. People with complete achromatopsia have difficulty in seeing detail. Complete achromatopsia is caused by an autosomal recessive allele and is usually very rare in populations with only one in 40 000 being affected. However on the Pacific island of Pingelap ten percent of the population are affected.

One form of red-green colour blindness is caused by a sex-linked recessive allele which affects more men than women. People with this red-green colour blindness are unable to distinguish between red and green, and also between other colours. They have green-sensitive cones but the photoreceptive pigment they contain does not function.

Scientists investigated the use of gene therapy to correct red-green colour blindness in monkeys. They injected viruses containing the gene for the green-sensitive pigment directly into the eyes of the monkeys. Although the monkeys maintained two years of colour vision, there is debate on whether this form of gene therapy is worthwhile. No clinical trials of this procedure have been carried out on humans. Current research into the treatment of red-green colour blindness involves the use of induced pluripotent stem cells (iPS cells). The use of iPS cells could have advantages over the use of gene therapy.

Use the information in the passage and your own knowledge to answer the following questions.

**1 0 . 1** People with complete achromatopsia have difficulty in seeing detail (lines 2–3).

Explain why.

**[3 marks]**


Questions, mark schemes and examiners' report extracts © AQA.

**Question 6 · A level Paper 2 · June 2018 · Q10.4 · 3 marks**

**1 0 . 4** People with red-green colour blindness are unable to distinguish between red and green, and also between other colours (lines 8–10).

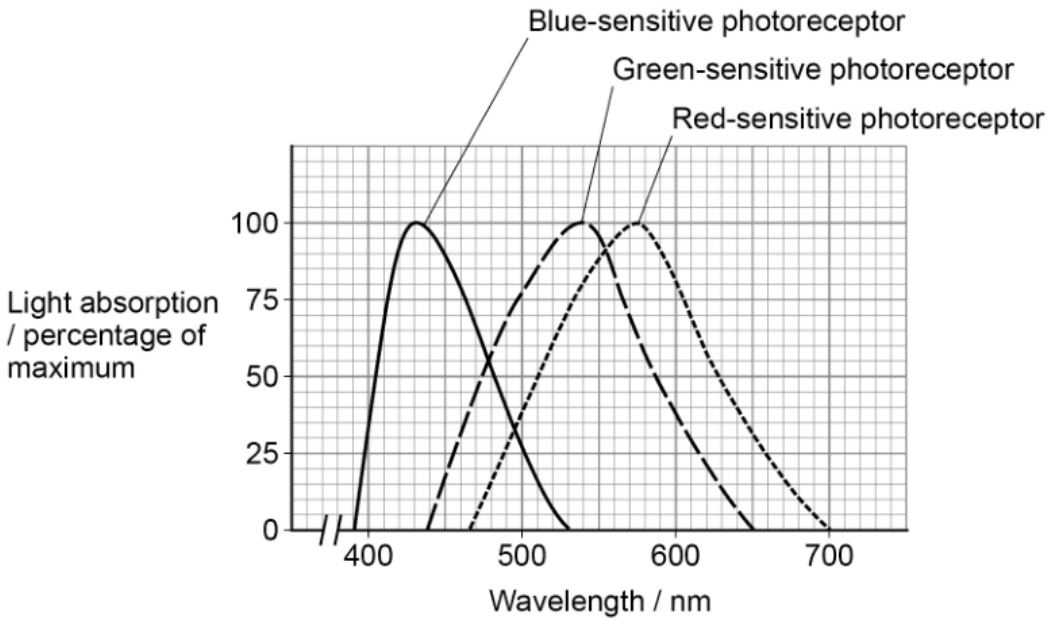
Explain why.

**[3 marks]**


Questions, mark schemes and examiners' report extracts © AQA.

**0 5 . 1** **Figure 3** shows the wavelengths of light absorbed by three types of photoreceptor found in the human retina.

**Figure 3**




Use **Figure 3** and your knowledge of colour vision to explain how an orange colour is seen at 600 nm

**[3 marks]**


Questions, mark schemes and examiners' report extracts © AQA.

**Question 8 · A level Paper 2 · June 2024 · Q06.1 · 5 marks**

**0 6 . 1** Describe the myogenic stimulation of the heart and how the regular contraction of the atria and ventricles is coordinated.

Do **not** include the autonomic nervous system in your answer.

**[5 marks]**


Questions, mark schemes and examiners' report extracts © AQA.

**Question 9 · A level Paper 2 · June 2017 · Q01.1 · 4 marks**

**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]**


Questions, mark schemes and examiners' report extracts © AQA.

**Question 10 · information from earlier in the question**

**1 0** Read the following passage.

North American black bears can hibernate for up to 7 months without food or water. The bears survive using the fat stores in their bodies. The bears build up the fat stores during the summer. During hibernation, the heart rate of black bears decreases from a summer mean of 55 beats per minute to 14 beats per minute. Their metabolic rate falls by 75%.

In many mammals, 'uncoupling proteins' help to maintain a constant body temperature during hibernation. Uncoupling proteins are found in the inner mitochondrial membrane and act as proton channels during chemiosmosis. However, these proton channels do not generate ATP.

In the mountains of North America, when winter changes into spring, the coat colour of snowshoe hares changes from white to brown. Climatic changes have caused the snow to melt earlier. This has reduced the survival rate of snowshoe hares in these habitats. The change in coat colour occurs when new fur replaces old fur. This is called moulting. Recent research has shown that snowshoe hares within a population moult at different times. Moulting at different times could be a major factor in ensuring the survival of snowshoe hare populations.

Use the information in the passage and your own knowledge to answer the following questions.


Questions, mark schemes and examiners' report extracts © AQA.

**Question 10 · A level Paper 2 · November 2020 · Q10.2 · 4 marks**

**10.2** 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]**


Questions, mark schemes and examiners' report extracts © AQA.

**Question 11 · information from earlier in the question**

**1 0** Guillain–Barré syndrome is a rare disease in which the immune system damages the myelin sheath of neurones. Myelin sheath damage can cause a range of symptoms, for example numbness, muscular weakness and muscular paralysis. Sometimes, neurones of the autonomic nervous system are affected, causing heart rate irregularities.

Huntington's disease is a disorder caused when a protein called huntingtin damages the brain. Huntingtin is produced because of a dominant, mutant allele.

The first successful drug trial to reduce concentrations of huntingtin in the human brain involved 46 patients. The patients received the drug for 4 months. The concentration of huntingtin was reduced in all the patients. The drug was injected at the base of the spine into the cerebrospinal fluid bathing the brain and spinal cord. The drug contains single-stranded DNA molecules. These single-stranded molecules inhibit the mRNA needed to produce huntingtin.

Symptoms of Huntington's disease can start at any time, but usually develop between 30 and 50 years of age. The likelihood and age when symptoms start are linked to the number of CAG base sequence repeats in the gene for Huntington's disease. However, recent studies have suggested that epigenetics may also affect the age when symptoms first start.

**Question 11 · A level Paper 2 · June 2019 · Q10.2 · 3 marks**

**1 0 . 2** Sometimes Guillain–Barré syndrome causes heart rate irregularities (lines 4–5).

Suggest and explain why.

**[3 marks]**


Questions, mark schemes and examiners' report extracts © AQA.

**Question 12 · A level Paper 2 · June 2025 · Q06.3 · 3 marks**

**0 6 . 3** The parasympathetic nervous system (PNS) uses acetylcholine as its neurotransmitter. Atropine is an anticholinergic drug that attaches to postsynaptic receptors.

Atropine can be used to increase the heart rate in patients with bradycardia (a slower than normal heart rate).

Use the information provided to explain how atropine causes an increase in the heart rate.

**[3 marks]**


Questions, mark schemes and examiners' report extracts © AQA.

A research scientist investigated the effect of caffeine on heart rate in human volunteers.

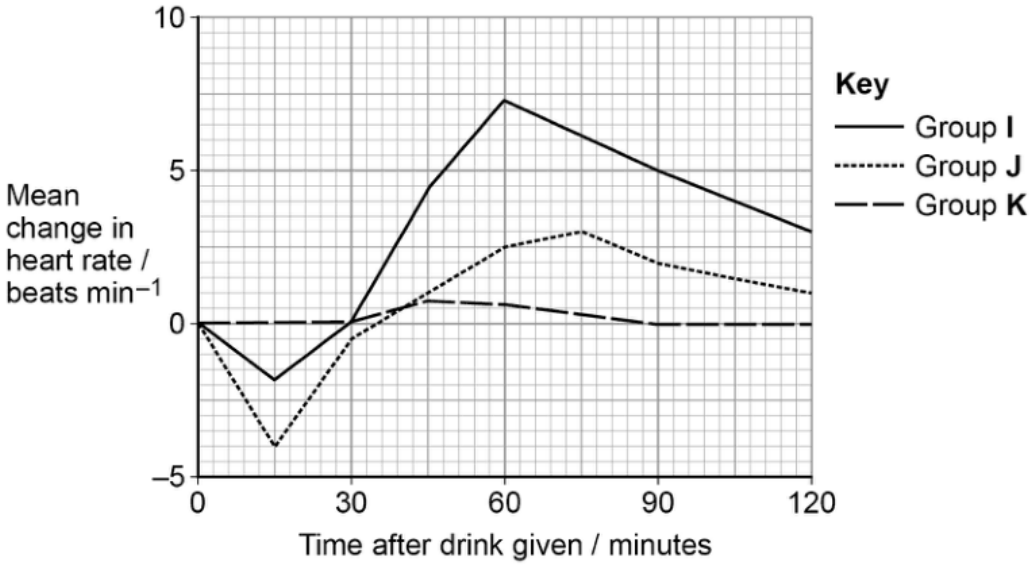
The scientist divided volunteers into three groups. Each group was given the same volume of fluid.

- Each member of Group **I** was given a sports drink containing caffeine and sugar.
- Each member of Group **J** was given a sports drink containing caffeine and no sugar.
- Each member of Group **K** was given water.

The scientist recorded the volunteers' heart rate before the drink was given and for 120 minutes after the drink was given.

Her results can be seen in **Figure 3**.

**Figure 3**




**0 3 . 4** Caffeine affects the autonomic nervous system.

Suggest how caffeine could account for the results of Group **I** in **Figure 3** at 60 minutes.

**[2 marks]**


Questions, mark schemes and examiners' report extracts © AQA.

**Question 14 · A level Paper 3 · June 2019 · Q03.6 · 2 marks**

**0 3 . 6** The increase seen in Group **I** could be due to the combination of caffeine and sugar.

Suggest **one** drink to be given to an **additional** group that should be investigated to find out if this is true.

Give a reason for your answer.

**[2 marks]**

Group to be given _____

Reason _____


Questions, mark schemes and examiners' report extracts © AQA.

## Mark schemes

**Question 1 · A level Paper 3 · June 2022 · Q02.1 · 2 marks**

| | | | |
|---|---|---|---|
| **02.1** | **Two** marks for **three** correct structures,<br>**one** mark for **two** correct structures;;<br>P = Capsule/lamella(e)<br>Q = Axon (membrane)<br>R = Schwann cell(s)<br>**OR**<br>R = Myelin (sheath) | 2<br>(2 x AO1) | P – accept connective tissue<br>Q – accept (sensory) neurone<br>Q – accept nerve cell<br>Q – ignore nerve |


Questions, mark schemes and examiners' report extracts © AQA.

**Question 2 · A level Paper 3 · June 2023 · Q01.1 · 3 marks**

| | | |
|---|---|---|
| **01.1** | 1. (There are) stretch-mediated sodium ion channels (in the membrane);<br>2. (Increased pressure) deforms/changes (sensory neurone/axon) membrane/lamella(e)<br>**OR**<br>(Increased pressure) deforms/changes sodium ion channels;<br>3. Sodium ion channels open;<br>4. Sodium ions diffuse in;<br>5. Depolarisation (leading to generator potential); | 3 max<br>(3 x AO1) |

1. 2. 3. or 4. Accept $Na^+$

**Max 2** if only reference to sodium and not sodium ions

4. Accept sodium ions move in down a concentration gradient
5. Accept inside becomes positive


Questions, mark schemes and examiners' report extracts © AQA.

**Question 3 · A level Paper 2 · November 2020 · Q01.2 · 3 marks**

| | | | |
|---|---|---|---|
| **01.2** | 1. High (visual) <u>acuity</u>;<br>2. (Each) cone is connected to a single neurone;<br>2. (Cones send) separate (sets of) impulses to brain; | 3 | 2. Accept no retinal convergence.<br>2. Accept 'bipolar/nerve cell' for neurone.<br>3. Accept 'optic nerve' for brain.<br>3. Reject 'signals', 'messages' for 'impulses'.<br>3. Accept 'action potential'. |


Questions, mark schemes and examiners' report extracts © AQA.

**Question 4 · A level Paper 2 · November 2020 · Q01.4 · 3 marks**

| | | |
|---|---|---|
| **01.4** | 1. High (visual) sensitivity;<br>2. Several rods connected to a single neurone;<br>3. Enough (neuro)transmitter to reach/overcome threshold<br>**OR**<br>Spatial summation to reach/overcome threshold; | 3 |

1. Accept retinal convergence.

2. Accept 'bipolar/nerve cell' for neurone

2. Accept 2, 'many' or more for 'several'

3. Reject 'signals', 'messages' for 'impulses'.

3. Accept named neurotransmitter.

3. Accept depolarisation, 'action potential' or 'generator potential' for 'to reach threshold'.

3. Generator potentials combine to reach threshold/ depolarisation/action potential/generator potential.


Questions, mark schemes and examiners' report extracts © AQA.

**Question 5 · A level Paper 2 · June 2018 · Q10.1 · 3 marks**

| | | | |
|---|---|---|---|
| 10.1 | 1. No (functional) cones<br>**OR**<br>Only rods;<br><br>2. Cones are connected to a single neurone<br>**OR**<br>Several rods connected to a single neurone;<br><br>3. (Cones) Separate (sets of) impulses to brain<br>**OR**<br>(Rods) Single (set of) impulse/s to brain; | 3 | 2. Accept correct reference to retinal convergence<br><br>2. Accept 'bipolar/nerve cell' for neurone<br><br>2. Accept 'many' 2 or more for 'several'<br><br>3. Accept 'optic nerve' for brain<br><br>3. Reject 'signals', 'messages' for 'impulses'<br><br>3. Accept 'action potential' |


Questions, mark schemes and examiners' report extracts © AQA.

| | | |
|---|---|---|
| **10.4** | 1. Green sensitive pigment/cones non-functional<br>**OR**<br>Cones that detect green light non-functional;<br>2. Three different types of pigment/cone;<br>3. Other/different colours ('seen') due to stimulation of more than one cone/pigment; | 3 |

1, 2 and 3. Reject reference to 'green cones'/ 'blue cones / 'red cones' but once only

1, 2 and 3. Reject reference to 'green pigment'/ 'blue pigment/ 'red pigment'

but once only **and only if 'green cones' etc, (see above) has not been rejected.**


Questions, mark schemes and examiners' report extracts © AQA.

**Question 7 · A level Paper 2 · June 2023 · Q05.1 · 3 marks**

| | | |
|---|---|---|
| **05.1** | 1. (Colour vision involves) <u>cones</u>;<br>2. (Each type of) photoreceptor has a different pigment<br>**OR**<br>(Each type of) photoreceptor absorbs particular/different (range of) wavelength(s)<br>**OR**<br>(Each type of) photoreceptor stimulated by particular/different (range of) wavelength(s);<br>3. Greater absorption by 'red sensitive' than 'green sensitive' (cells/photoreceptors/cones)<br>**OR**<br>Provides percentage values which indicate difference in light absorption (at 600nm)<br>**OR**<br>More impulses to brain from 'red sensitive' than 'green sensitive' (photoreceptors/cones)<br>**OR**<br>More impulses along optic nerve from 'red sensitive' than 'green sensitive' (photoreceptors/cones); | 3<br>(3 x AO2) |

1, 2 and 3. Reject 'red cones/photoreceptors' and 'green cones/photoreceptors' only **once**.

1 and 2. Each cone has a different pigment or absorbs particular wavelengths = **two**


Questions, mark schemes and examiners' report extracts © AQA.

**Question 8 · A level Paper 2 · June 2024 · Q06.1 · 5 marks**

| | | | |
|---|---|---|---|
| **06.1** | 1. SAN releases (wave of) electrical activity;<br>2. (So) atria contract (at the same time);<br>3. AVN relays/passes electrical activity after a (short) delay;<br>4. (Via) Purkyne tissue in/and bundle of His;<br>5. (So) ventricles contract (at the same time from bottom upwards); | 5<br>(5 x AO1) | Penalise **one** mark for incorrect sequence.<br>1 and 3. Accept 'impulse/s' or 'wave of depolarisation' for electrical activity but reject 'signal', 'message' **once** only.<br>1 and 3. Accept 'wave of excitation'.<br>2 and 5. Accept systole for 'contract'.<br>4. Accept 'Purkinje' for Purkyne or similar spelling.<br>If only the cardiac cycle is described allow one mark max atria contract and then ventricles contract. |

**Question 9 · A level Paper 2 · June 2017 · Q01.1 · 4 marks**

| | | | |
|---|---|---|---|
| 01.1 | 1. Chemoreceptors detect rise in $CO_2$/$H^+$/acidity/carbonic acid/fall in pH<br>OR<br>Baro/pressure receptors detect rise in blood pressure;<br>2. Send impulses to cardiac centre/medulla;<br>3. More impulses to SAN;<br>4. By sympathetic (nervous system for chemoreceptors/$CO_2$)<br>OR<br>By parasympathetic (nervous system for baro/pressure receptors/blood pressure); | 4 | 1. Ignore: location of receptors.<br>1. Ignore: chemoreceptors detect oxygen.<br>2 and 3. Accept: action potentials.<br>2. Reject: 'messages', 'signals', 'an impulse' or an 'action potential'.<br>3. Ignore: messages', 'signals', 'an impulse' or an 'action potential' as emphasis here is on increase in frequency. |


Questions, mark schemes and examiners' report extracts © AQA.

**Question 10 · A level Paper 2 · November 2020 · Q10.2 · 4 marks**

| | |
|---|---|
| **10.2** | 1. (Lower metabolism so) less/low $CO_2$ (in blood);<br>2. (Detected by) chemoreceptors;<br>3. (Chemoreceptors) located in aorta/medulla<br>**OR**<br>(Chemoreceptors) located in carotid artery;<br>4. Fewer impulses to cardiac centre;<br>**OR**<br>Fewer impulses to medulla (oblongata);<br>5. (More) impulses along parasympathetic/vagus pathway/neurones/nerve<br>**OR**<br>Fewer impulses along sympathetic pathway/neurones/nerve;<br>6. (To) SAN; |

| | |
|---|---|
| | **If neither mark point 1 or 2 credited = 3 max.**<br>1. Accept increase in pH or decrease in H ions/acidity for less $CO_2$.<br>Ignore baroreceptors.<br>2. Ignore detects oxygen, (concentration).<br>3. Accept carotid body or |


Questions, mark schemes and examiners' report extracts © AQA.

**Question 11 · A level Paper 2 · June 2019 · Q10.2 · 3 marks**

| | | | |
|---|---|---|---|
| 10.2 | 1. Slower/fewer impulse(s) along sympathetic/parasympathetic (pathway/neurones);<br><br>2. (Impulses) from cardiac centre<br>**OR**<br>(Impulses) from medulla;<br><br>3. To SAN; | 3 | 1. Accept action potentials for impulses.<br><br>1.Reject no impulses.<br><br>1, 2 and 3. Ignore 'information' but reject first mark awarded if answer refers to messages/signals for impulses. Reject even if impulse/s also referred to. |


Questions, mark schemes and examiners' report extracts © AQA.

**Question 12 · A level Paper 2 · June 2025 · Q06.3 · 3 marks**

| | | |
|---|---|---|
| 06.3 | 1. Less/no acetylcholine binds (to receptors);<br>2. Fewer/no impulse(s)/action potentials (at synapse before SAN)<br>**OR**<br>Less/no depolarisation by PNS (at synapse before SAN)<br>**OR**<br>PNS/acetylcholine decreases heart rate<br>**OR**<br>More depolarisation occurs (as acetylcholine is inhibitory at SAN)<br>**OR**<br>Less/no inhibition by PNS/acetylcholine (at SAN);<br>3. (Refers to) SAN; | 3 (3 x AO1) |

1 and 2. Accept neurotransmitter or abbreviations for e.g. ACh, Ach (as named in question) for 'acetylcholine'

1. Ignore competitive inhibition unless it refers to enzyme or active site, then reject

2. Note: First two options relate to atropine acting at synapse in PNS before SAN. Last 2 options relate to atropine acting


Questions, mark schemes and examiners' report extracts © AQA.

**Question 13 · A level Paper 3 · June 2019 · Q03.4 · 2 marks**

| | | | |
|---|---|---|---|
| **03.4** | 1. More impulses/action potentials along sympathetic (nervous system pathway/branch);<br>2. To SAN increasing the heart rate (seen in **Figure 3**); | 2 | 1. Ignore signals/information/ messages<br>1. Idea of more impulses/action potentials is required |

**Question 14 · A level Paper 3 · June 2019 · Q03.6 · 2 marks**

| | | | |
|---|---|---|---|
| **03.6** | **Group to be given**<br>1. Sugar solution (only)<br>**OR**<br>A drink with sugar (**and** no caffeine);<br>**Reason**<br>2. To show/prove that sugar (alone) is not causing the increases (in HR)<br>**OR**<br>To show that sugar does not have an effect; | 2 | 1. Accept 'glucose' for sugar<br>1. Ignore named drinks unless qualified<br>1. Ignore 'sugar' by itself<br>1. Ignore references to use of a placebo tablet<br>2. Accept 'to see the effect of sugar' |


Questions, mark schemes and examiners' report extracts © AQA.