



A-Level Biology

Receptors

Question Paper

Time available: 64 minutes

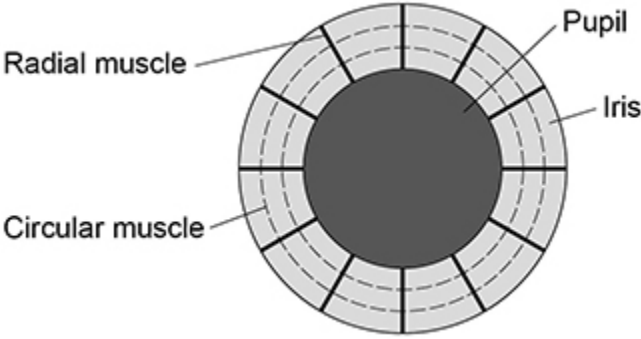
Marks available: 44 marks

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1.

The iris in the human eye is a muscular structure. The iris changes the size of the pupil.

The diagram below shows the muscles in the iris.

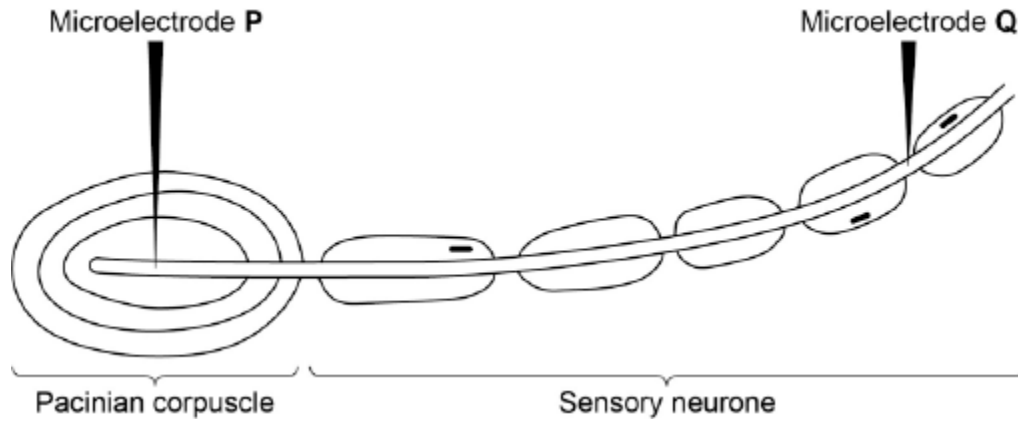


(a) Suggest and explain how the interaction between the muscles labelled in the diagram above could cause the pupil to constrict (narrow).

(2)

2. A biologist investigated the stimulation of a Pacinian corpuscle in the skin of a fingertip. She used microelectrodes to measure the maximum membrane potential of a Pacinian corpuscle and its sensory neurone when different pressures were applied to the fingertip.

The figure below shows the Pacinian corpuscle, its sensory neurone and the position of the microelectrodes.



The table below shows some of the biologist's results.

Pressure applied to the fingertip	Membrane potential at P / millivolts	Membrane potential at Q / millivolts
None	-70	-70
Light	-50	-70
Medium	+30	+40
Heavy	+40	+40

- (a) Explain how the resting potential of -70 mV is maintained in the sensory neurone when no pressure is applied.

(2)

(b) Explain how applying pressure to the Pacinian corpuscle produces the changes in membrane potential recorded by microelectrode **P**.

(3)

(c) The membrane potential at **Q** was the same whether medium or heavy pressure was applied to the finger tip. Explain why.

(2)

(d) Multiple sclerosis is a disease in which parts of the myelin sheaths surrounding neurones are destroyed. Explain how this results in slower responses to stimuli.

(2)

(Total 9 marks)

3.

The human retina contains three types of cone cells:

- cone cells sensitive to red light
- cone cells sensitive to green light
- cone cells sensitive to blue light.

Staring at a white card causes all three types of cone cells to be stimulated.

A student investigated the duration of afterimages using red squares and purple squares. His results are shown in the table.

Colour of square	Cone cell(s) stimulated	Colour of afterimage	Mean duration of afterimage / seconds
Red	Red	Blue-green	15
Purple	Red and blue	Green	12

(a) Suggest a null hypothesis for this investigation.

(1)

(b) Suggest a statistical test that would be appropriate for this investigation. Give a reason for your answer.

Statistical test _____

Reason for choice _____

(1)

- (c) After the student had stared at a purple square, he saw a green afterimage. Suggest why.

(3)

- (d) Use the results in the table to calculate the percentage increase in the mean duration of the afterimage after staring at the red square compared with the purple square.

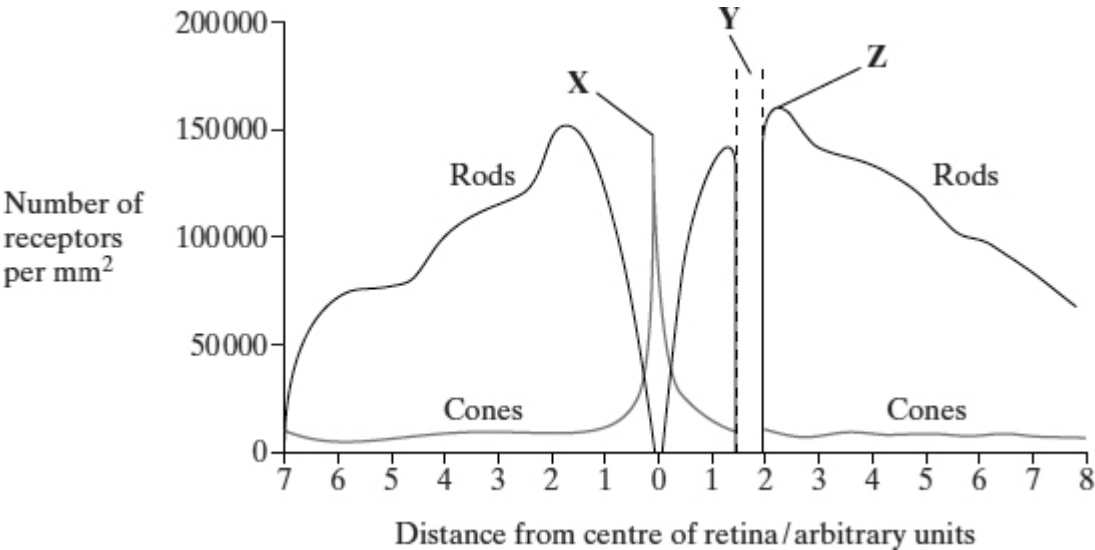
Answer = _____ %

(2)

(Total 7 marks)

4.

The graph shows the distribution of rod cells and cone cells across the retina of a human eye.



Use the diagram to explain why

(i) no image is perceived when light is focused on the retina at Y;

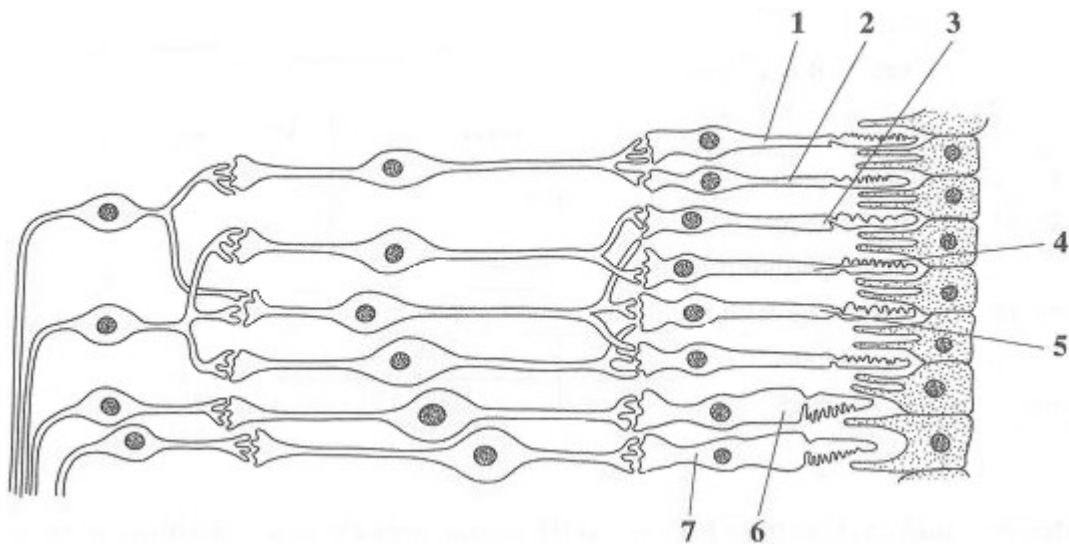
(1)

(ii) an image formed at X is perceived in more detail than an image formed at Z.

(2)

(Total 3 marks)

5. The diagram shows part of the retina in a human eye.



(a) Explain each of the following observations.

- (i) When light falls on cells **1** and **2**, only one spot of light is seen. But, when light falls on cells **2** and **3**, two spots of light are seen.

(1)

- (ii) When one unit of light energy falls on cell **3**, no light is seen. But, when one unit of light energy falls on cell **3**, one unit falls on cell **4** and one unit falls on cell **5**, light is seen.

(3)

- (b) Cells of the same type as cells **6** and **7** are found in large numbers at the fovea. This results in colour vision with high visual acuity.

Explain what causes vision using the fovea.

- (i) to be in colour;

(1)

- (ii) to have high visual acuity.

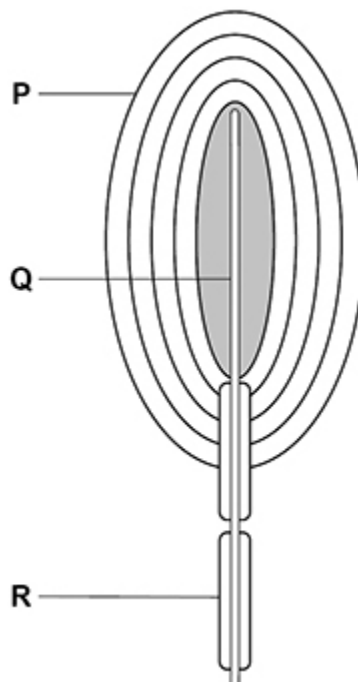
(1)

(Total 6 marks)

6.

Figure 1 shows a diagram of a Pacinian corpuscle.

Figure 1



- (a) Name the structures labelled **P**, **Q** and **R** shown in **Figure 1**.

P _____

Q _____

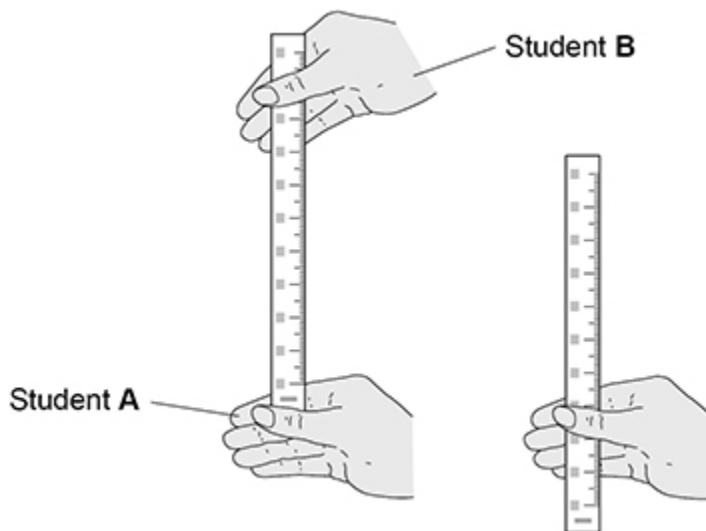
R _____

(2)

Two students (**A** and **B**) investigated reaction time in response to touch.

- Student **A** sat with her eyes shut and her forearm resting on a worktop so that her hand was over the edge.
- Student **B** held a ruler vertically between student **A**'s thumb and first finger, with the ruler at 0 mm lightly touching student **A**'s first finger.
- Student **B** released the ruler.
- As soon as student **A** felt the ruler fall, she closed her thumb and first finger to catch the ruler as shown in **Figure 2**.
- Student **B** measured the distance the ruler had fallen to the nearest mm

Figure 2



The test was repeated three more times using the same hand to catch the ruler. **Table 1** shows student **A**'s results.

Table 1

Trial	Distance the ruler has fallen / mm
1	79
2	97
3	10
4	94

The student was able to convert these distances into reaction times using **Table 2**.

Table 2

Distance the ruler fell / mm	Reaction time / ms
10	45
20	64
30	78
40	90
50	101
60	111
70	120
80	128
90	136

(b) Calculate the percentage uncertainty in the measurement of **Trial 1** in **Table 1**.

Put a Tick (✓) in the correct box below.

0.633%

1.27%

2.53%

12.6%

(1)

(c) In this investigation, it is not possible for a student to react in less than 45 ms

Suggest **one** explanation for the value recorded in **Trial 3** in **Table 1**.

(1)

- (d) Student **A** estimated that the length of the nerve pathway involved was 175 cm
Use **Table 1** and **Table 2** to calculate the mean speed of nerve impulse transmission.
Do **not** use the value for **Trial 3** in your calculation.

Answer _____ m s⁻¹

(2)

- (e) In response to touch, nerve impulses can be transmitted at speeds of 76.2 m s⁻¹
Suggest **three** reasons why, in this investigation, the estimated speed of student **A**'s impulse transmission was less than 76.2 m s⁻¹

1 _____

2 _____

3 _____

(3)

(Total 9 marks)