

## 6.2 Organisms - Responses to their environment (A-Level Only) - Receptors Mark schemes

### Q1.

- (a) 1. Three peaks / three maximum values / three maxima;  
2. At different wavelengths / different colours / blue, green and red;  
*Accept 'at 430nm, 515nm, 585nm' ( $\pm 5\text{nm}$  for all)*

2

- (b) Overlap between different types of cone cells / some wavelengths / colours are detected by more than one type of cone cell;

1

- (c) 1. Birds have four peaks, humans have three peaks;  
2. Birds and humans have types (that peak) at 515 nm/green and 585 nm/red;  
3. (Similar type) but (peak) at 430 nm in humans and 450 nm in birds;  
4. Birds have a peak / can see at 370 nm / shorter wavelength / UV range;  
*1. Birds have four different types of cone, humans have three*  
*Accept all numbers read from the graph within  $\pm 5$  nm.*  
*3. Do not accept 'both humans and birds absorb blue'*

3 max

- (d) 1. (Each cone cell has) separate neurone to brain / separate bipolar neurone / separate ganglion cell;  
2. (So) no retinal convergence / impulses from each cone kept separate / no summation of impulses;  
*Allow converse for rod cells*  
*2. Accept idea that each cone only represents a small area of the retina*

2

- (e) Between 230 790 to 231 000 = 2 marks;

Area of fovea =  $1.54 \text{ mm}^2$  = 1 mark;

*Using  $\pi$  as 3.14 or 22/7 or  $\pi$  on the calculator*

*No credit can be awarded if the area has been incorrectly calculated*

**Q2.**

- (i) rhodopsin bleached / broken down by light;  
time for resynthesis; 2
  - (ii) rhodopsin / pigment absorbs green light more readily than red / is  
more sensitive to green light;  
(after resynthesis) less (intense) green light needed to break down  
rhodopsin (than red); 2
  - (iii) white has (high proportion of) wavelengths to which rhodopsin not  
sensitive; 1
- [5]**

**Q3.**

- (a) The colour of the square has no effect on the duration of the afterimage /  
there is no difference in the duration of the afterimage **with** squares of  
different colours;  
*Accept other ways of expressing the null hypothesis  
but reference must be made to colour of square  
and the duration of the afterimage  
Reject 'there is no difference in the duration of the  
afterimage **and** the colour of the square'* 1
- (b) Standard error (with 95% confidence limits)/t test  
because looking for differences between means /  
measurements (from different samples);  
*Test and reason required for the marking point* 1
- (c) 1. (When staring at purple) red (sensitive) and  
blue (sensitive) cones are stimulated / green  
(sensitive) cones are not stimulated;  
2. Red and blue cone cells become exhausted / stop working;  
3. (Afterimage due to) green (sensitive) cone cells working;  
*Allow 1 extra mark up to the maximum of 3 for  
additional detail to marking point 2 e.g. exhaustion  
of pigment, exhaustion of neurotransmitter,  
exhaustion of ATP* 3
- (d) 25% = 2 marks;  
15-12/12 × 100 = 1 mark; 2

**Q4.**

- (a) 1. Membrane more permeable to potassium ions and less permeable to sodium ions;  
2. Sodium ions actively transported / pumped out and potassium ions in. 2
- (b) 1. (Pressure causes) membrane / lamellae to become deformed / stretched;  
2. Sodium ion channels in membrane open and sodium ions move in;  
3. Greater pressure more channels open / sodium ions enter. 3
- (c) 1. Threshold has been reached;  
2. (Threshold or above) causes maximal response / all or nothing principle. 2
- (d) 1. Less / no saltatory conduction / action potential / impulse unable to 'jump' from node to node;  
2. More depolarisation over length / area of membranes. 2

**[9]****Q5.**(a) Any **two** from:

- light
- pressure
- touch
- temperature
- chemicals
- (loud) noise
- smell;

*Two required for 1 mark**Do not accept unqualified reference to dust / particles / objects**Accept (rapid) movement (of particles / air) towards the eye**Accept humidity / moisture / tears*

1

- (b) 1. Standard deviations / standard errors;

2. (So) likely to overlap; 2
- (c) 1. Would not know the patient's / human's normal blink rate so unable to make a comparison;
2. Blink rate could be affected by stress of seeing a doctor;
3. Many factors could affect blink rate so it would be difficult to tell if blink rate was due to illness 2 max
- (d) 1. Not possible to predict intermediate values;
2. Only one result for each time period / not mean values; 2
- (e) Collected paired data; 1
- (f) 1. No / low influx of sodium ions;
2. So no depolarisation / action potential;  
2. *'so no impulses' insufficient* 2
- (g) 1. Allows calcium ions in;
2. At end of presynaptic neurone;
3. Causing release of neurotransmitter;  
1. *Accept  $Ca^{2+}/Ca$  ions but not  $Ca/Ca^+$*   
2. *The idea of the end of the presynaptic neurone must be given e.g. presynaptic knob* 3
- (h) 1. Reference to large group size;
2. Reference to matching a specific, named variable;
3. Applying a statistical test to the data;  
1. *Accept  $\geq 20$  / many / lots' but not 'several / less than 20'*  
2. *Accept any named variable other than age.*  
3. *Accept 'use SE / 95% confidence limits'* 3

[16]

**Q6.**

- (a) 1. (Increased pressure) deforms / changes stretch-mediated sodium (ion) channel;  
 2. (Sodium channels open and) sodium ions flow in;  
*Accept Na<sup>+</sup>*  
 3. Depolarisation (leading to generator potential).  
*Accept correct description of depolarisation*

3

- (b) Value between 2.17:1 and 2.29:1;  
*Accept rounding up to 2.2 or 2.3*  
*Accept: number without : 1*  
*Correct working showing answer but incorrect rounding in answer line = 1*

Values between 117 to 119 and between 52 to 54 found but ratio wrong round = 1 mark.

*Wrong way round gives answer between 0.35:1 and 0.46:1*

2

- (c) 1. Parasympathetic greater effect than sympathetic;  
*Ignore: descriptions of graph*  
 2. Parasympathetic keeps heart rate down / lower / decreases heart rate (as blood pressure increases);  
 3. Sympathetic keeps heart rate up / higher / increases heart rate (as blood pressure increases);  
*2. and 3. Accept converse for blood pressure decreases*  
 4. Parasympathetic greatest / greater effect at high blood pressure / sympathetic greatest effect at low blood pressure.

3 max

[8]

### Q7.

- (i) no (photo)receptor cells at **Y** / no rods and cones;
- (ii) **X** has many / only cones / more cones than **Z**;  
 which each synapse to a single neurone / bipolar cell / no retinal convergence;  
 OR  
**Z** has mainly rods / more rods than cones;  
 which share / converge on neurones / bipolar cells;

1

2

[3]

### Q8.

- (a) (i) 1 and 2 share neurone but 2 and 3 have separate neurones (to brain);  
*Ignore wrong names of neurones* 1
- (ii) 1 unit is sub-threshold / 3 units are above threshold / give sufficient depolarisation;  
(1 unit) No impulses / no action potential / in (sensory) neurone / does not stimulate (sensory) neurone / 3 units → impulses;  
(Spatial) summation / sufficient neurotransmitter released / from 3 receptors / insufficient N-T from one;  
*Reject 'temporal'* 3
- (b) (i) (Three) different types of (cone) cells / types 6 and 7 sensitive to different wavelengths / different frequencies / different colours;  
(ii) Impulses along separate neurone from each receptor cell / each receptor cell connects to separate neurone; 2
- [6]**

**Q9.**

- (a) no rods at blind spot or fovea;  
greater distribution of rods at edge; 2
- (b) more rods and no / fewer cones present;  
rods at the fovea / rods not mainly at periphery;  
  
rods have high sensitivity / show retinal convergence / converse for cones;  
  
rhodopsin 'bleached' at low light intensities / iodopsin 'bleached';  
at high light intensities; 3 max
- [5]**

**Q10.**

- (a) Colour detected by cone cells;  
Fovea contains (only / mainly) cone cells;  
Three types of cone / cells described / each sensitive to different wavelength / to red or green or blue;  
*Max 2 if 'rods' and 'cones' confused consistently* 3
- (b) (i) Each receptor (in fovea)/each cone connected to separate neurone / rods/cells in other parts share a neurone;  
*Accept nerve cell / nerve fibre* 1
- (ii) Many rods in other parts of retina;  
Rhodopsin / pigment in receptors / rod cells very sensitive to light/

works in low light;  
Receptors / rods connected in groups to ganglion cell / neurone;  
Summation;  
Description of summation, eg if enough light above threshold  
hits any cells in the group, then get nerve impulses to brain/along  
optic nerve;

3 max

[7]

**Q11.**

(a) Only 3 neurones / nerve cells (in reflex arc)

1

- (b)
1. Rapid;
  2. Protect against damage to body tissues;
  3. Do not have to be learnt;
  4. Help escape from predators;
  5. Enable homeostatic control.

2 max

- (c)
1. Neurotransmitter only made in / stored in / released from pre-synaptic neurone;
  2. (Neuro)receptors only on the post-synaptic membrane;

2

- (d)
1. Axon **P** is myelinated;
  2. So shows saltatory conduction / impulses jump between nodes of Ranvier

**OR**

3. Axon **P** has a larger diameter;
4. So less resistance to flow of ions.

*Mark as 1 & 2 **OR** 3 & 4*

2

[7]

**Q12.**

(a) (epithelial cell) of tubule cells carry out active transport;  
transport chloride / sodium ions out (of filtrate);  
against concentration gradient;  
into surrounding tissue / tissue fluid;  
creates / maintains water potential gradient for water reabsorption;  
countercurrent multiplier;

5 max

(b) if water potential of blood falls, detected by receptors in

hypothalamus;  
leads to ADH released from pituitary gland;  
ADH makes cells of collecting duct / distal convoluted tubule  
permeable to water;

*(accept DCT)*

water leaves filtrate by osmosis;  
smaller volume of urine produced;

*(accept converse if water potential of blood rises)*

**4 max**

- (c) (autonomic reflex),  
autonomic ganglion involved;  
extra synapse outside the spinal cord;  
inhibitory rather than excitatory neurone;  
more neurones involved;

**2 max**

**[11]**