

1. (a) (i) Several rod cells to each neuron / bipolar cell/each synapse/convergence principle of additive effect of light striking several rod cells/(spatial) summation; 2
- (ii) Each cone connects to a single neurone/no convergence; brain receiving information from each cone cell individually; 2
- (b) (i)  $-60$  millivolts; 1
- (ii) Increase in membrane permeability/gates open/channels open; to sodium ions; sodium ions enter; by diffusion/down gradient; (sodium) pump inhibited/eq; max 3
- (iii)  $0.6$  milliseconds; 1
- (iv) Calcium ion/ $\text{Ca}^{2+}$  entry; vesicles fuse with preSM ( and rupture); exocytosis of/release (neuro)transmitter substance / named e.g.; diffuse across gap; attach to receptors on post SM; (not “fuse with...”) increase permeability to sodium (ions) open Na channels/ref. e.p.s.p.; max 3
- (c) Insecticide binds to enzyme; ACh / neurotransmitter not hydrolysed/not broken down; remains attached to receptor; Na channels remain open; continued stimulus to muscles; tetanus/fatigue/continuous contraction/spasms/no relaxation; insect unable to move/fly/breathe; (I refs. energy/ATP) max 3
- (d) Diagram showing sarcomere shorter/Z lines closer together; 1
- (e) (i)  $\text{Ca}^{2+}$ : moves/detaches/changes shape of switch protein/blocking molecule/tropomyosin/troponin; expose binding sites/allows cross-bridge formation/eq; max 2  
activates myosin ATP-ase/enables myosin head to split ATP;
- (ii) Mitochondria: production of ATP; to attach/release/cock myosin head/ move myosin head/removal of  $\text{Ca}^{2+}$  ions; 2

2. (a) Resolving power/ability to distinguish small objects/close objects/tell close objects apart; 1
- (b) Relevant reference to **summation**;  
action potentials or generator potentials from several receptors/rods sent to single synapse/neurone;  
sufficient neurotransmitter released;  
action potential/electrical impulse more likely to be generated in this neurone/threshold more likely to be exceeded; max 2
3. (a) (Pressure) deforms / opens (sodium) channels; *reject any other ion*  
Sodium ions enter;  
Causing depolarisation;  
Increased pressure opens more channels / greater sodium entry; 2 max
- (b) (i) Arrow (labelled K) pointing out of node; 1
- (ii) Same amplitude of action potentials as in medium pressure graph but of a greater frequency; 1
- (c) (i) Answer between 0.7 and 0.9(ms); 1
- (ii) Correct answer based on candidate's response to (c) (i)  
(i.e. 80 divided by answer to previous question)  
*Accept correct working shown with no final answer* 1
- (d) (i) Action potential / impulse unable to "jump" from node to node / no saltatory conduction / action pd / impulse must pass through a greater amount of membrane;  
Slows / prevents impulse; 2 max
- (ii) Greater entry of sodium ions / greater exit of  $K^+$  in de-myelinated neurone;  
Ref. to active transport / ref. to ion pumps; 2
- (e) (i) Kinesis; *ignore prefix* 1
- (ii) Response is non-directional / related to intensity of the stimulus; 1
4. (a) (i) No sense cells/ no rods and/or cones at P; 1
- (ii) Maximum number of cones at Q; 1

[3]

[12]

- (b) Several rods have connections with one neurone/ bipolar cell;  
Idea of summation (of generator potentials);  
Exceed threshold;  
Individual (generator potentials) do not exceed threshold; max 3 [5]
5. (a) (Pressure) deforms/ opens (sodium) channels/ pores/ gates;  
*[Ignore: Deforms corpuscle]*  
Entry of sodium ions; *[Reject: Any other ion]* *[Accept: Error carried Forward of 'wrong' ion]*  
Causes depolarisation/ change in membrane potential/ generator potential;  
Reference to threshold potential; max 2
- (b) Sensory neurone correctly drawn and labelled;  
Relay neurone correctly drawn and labelled;  
Motor neurone correctly drawn and labelled; 3  
(Synapses need not be labelled)  
*[Note: If relay neurone is positioned incorrectly, then can allow marks for the other two if they are drawn correctly and synapse with the relay neurone]*  
*[Note: 1 mark if all 3 structures labelled correctly but drawn in white matter]* [5]
6. (a) (i) 1 and 2 share neurone but 2 and 3 have separate neurones (to brain); 1  
*Ignore wrong names of neurones*
- (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]

7. (i) no (photo)receptor cells at **Y**/no rods and cones; 1
- (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; 2
- [3]
8. (a) medulla; 1
- (b) **A** increase  
**B** increase; 1
- (c) it spreads through the atria / right atrium / through cardiac muscle;  
to the atrioventricular node;  
then through conduction fibres / bundle of His/Purkyne fibres); 3
- [5]

### 9. *General principles for marking the Essay:*

Four skill areas will be marked: scientific content, breadth of knowledge, relevance and quality of language. The following descriptors will form a basis for marking.

#### **Scientific content** (maximum 16 marks)

Category	Mark	Descriptor
	16	
<b>Good</b>	14	Most of the material of a high standard reflecting a comprehensive understanding of the principles involved and a knowledge of factual detail fully in keeping with a programme of A-level study. Some material, however, may be a little superficial. Material is accurate and free from fundamental errors but there may be minor errors which detract from the overall accuracy.
	12	
	10	
<b>Average</b>	8	A significant amount of the content is of an appropriate depth, reflecting the depth of treatment expected from a programme of A-level study. Generally accurate with few, if any fundamental errors. Shows a sound understanding of most of the principles involved.
	6	
	4	
<b>Poor</b>	2	Material presented is largely superficial and fails to reflect the depth of treatment expected from a programme of A-level study. If greater depth of knowledge is demonstrated, then there are many fundamental errors.
	0	

#### **Breadth of Knowledge** (maximum 3 marks)

Mark	Descriptor
3	A balanced account making reference to most if not all areas that might realistically be covered on an A-level course of study.
2	A number of aspects covered but a lack of balance. Some topics essential to an understanding at this level not covered.
1	Unbalanced account with all or almost all material based on a single aspect
0	Material entirely irrelevant.

#### **Relevance** (maximum 3 marks)

Mark	Descriptor
3	All material presented is clearly relevant to the title. Allowance should be made for judicious use of introductory material
2	Material generally selected in support of title but some of the main content of the essay is of only marginal relevance.
1	Some attempt made to relate material to the title but considerable amounts largely irrelevant.
0	Material entirely irrelevant or too limited in quantity to judge.

**Quality of language** (maximum 3 marks)

Mark	Descriptor
3	Material is logically presented in clear, scientific English. Technical terminology has been used effectively and accurately throughout.
2	Account is logical and generally presented in clear, scientific English. Technical terminology has been used effectively and is usually accurate.
1	The essay is generally poorly constructed and often fails to use an appropriate scientific style and terminology to express ideas.
0	Material entirely irrelevant or too limited in quantity to judge.

[25]

***Additional notes on marking***

Care must be taken in using these notes. It is important to appreciate that the only criteria to be used in awarding marks to a particular essay are those corresponding to the appropriate descriptors. Candidates may gain credit for any information providing that it is biologically accurate, relevant and of a depth in keeping with an A-level course of study. Material used in the essay does not have to be taken from the specification, although it is likely that it will be. These notes must therefore be seen merely as guidelines providing an indication of areas of the specification from which suitable factual material might be drawn.

In determining the mark awarded for breadth, content should ideally be drawn from each of the areas specified if maximum credit is to be awarded. Where the content is drawn from two areas, two marks should be awarded and where it is taken only from a single area, one mark should be awarded. However, this should only serve as a guide. This list is not exhaustive and examiners should be prepared to offer credit for the incorporation of relevant material from other areas of study.

10. (a) *one mark for conclusion:*  
maggots move to/respond to/prefer/like /red rather than green;  
*(reject 'most prefer red')*  
maggots move to/prefer/like areas of lower light intensity (except green);  
maggots respond more to colour than light intensity / do not respond to differences in light intensity;  
*(reject conclusion relating to single result)*
- one mark for:*  
evidence matching conclusion:  
more in red than green, but light intensity the same;  
more in segments with lower light intensity;  
more differences in different colours, little difference in light intensity;  
large difference in number of maggots on segments with 25 a.u.  
light intensity; 2 max
- (b) valid statement expressed as null hypothesis, i.e. in negative form, e.g. no difference in response to different colours / light intensities; 1  
*(must relate to a possible hypothesis)*
- (c) rotate box (so segments in different direction) / change order of coloured segments;  
place magnets around box / create alternative magnetic field; 1 max
11. (a) (i) Prevents sideways movement of IAA; 1  
(ii) Light does not destroy/change IAA;  
Diagram **D** shows total amount of IAA unchanged (by unilateral light);  
Light causes IAA to move to shaded side of shoot tip;  
Diagram **C** shows movement is in tip/not in agar block; 3 max

[4]

- (b) (i) Used in respiration / as energy source; 1  
*Q* Answers that refer to making energy should not be awarded credit.
- (ii) **Q** contains tip/site of IAA production; 2  
Addition of further IAA has little effect;  
*Q* Accept clear converse argument for **P**
- (iii) Inhibits (growth of) both in sucrose solution; 3  
Stimulates (growth of) both in sucrose and IAA solution;  
Greater effect in **P**;
- (c) (i) Uptake by active transport; 2  
(Evidence is that) heat-killed wild type has low/no uptake;
- (ii) Mutation increases number / frequency of proton/hydrogen 3  
ion pumps;  
(Which explains) increased uptake of IAA without DNP;  
DNP reduces uptake by mutant cells (to wild type value);

[15]