

BIOWELSH WORKSHEET FOR WJEC GCE A LEVEL BIOLOGY**UNIT 4 – VARIATION, INHERITANCE AND OPTIONS****OPTION C NEUROBIOLOGY AND BEHAVIOUR: WORKSHEET 1 (BW-A2-OptionC-W1) MARK SCHEME****GENERAL INSTRUCTIONS****Recording of marks**

Mark in red ink. One tick equals one mark, except in the extended response question, where a level of response scheme is used.

Write each question total in the box at the end of the question, and copy the totals onto the grid on the front cover of the worksheet. Add them to give the worksheet total out of 156.

Marking rules

Look at all of the work. Where the scheme says working is needed, the working must be seen. Mark crossed-out work if it has not been replaced. Give credit for correct, relevant answers that are not listed in the scheme.

Extended response question

Read the whole answer first. Decide which level descriptor fits the answer best, judging the overall quality. Then choose the mark within the level: the top mark when the answer matches both the content and the communication statements well, the middle mark when most of the content is there and the communication statement is partly met, and the bottom mark when only the content statements are matched.

Marking abbreviations

cao = correct answer only
ecf = error carried forward
bod = benefit of doubt
ORA = or reverse argument
owtte = or words to that effect

Notation: / separates alternatives; { } groups alternatives within a point; words in () are not needed for the mark; underlined words are essential; (1) is one mark.

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
1	(a)			A corpus callosum (1) C pituitary gland (1) D cerebellum (1) E medulla oblongata (1) Reject cerebrum for D	4			4		
	(b)			Any two (×1) from: • controls body temperature (1) • controls water balance / blood solute concentration / osmoregulation (1) • controls hunger / thirst / sleep (1) • controls the autonomic nervous system (1) • controls the pituitary gland / links the nervous and endocrine systems (1)	2			2		
	(c)			Any two (×1) from: • irregular breathing / ventilation rate not controlled (1) • abnormal heart rate (1) • abnormal blood pressure (1) • problems with swallowing / coughing / vomiting reflexes (1)		2		2		
	(d)			On the inner side of the temporal lobe / deep in each temporal lobe / below the cortex at the level of the ears (1) Consolidates short-term memories into long-term / permanent memory / spatial memory / controls cortisol release (1) Do not credit learning and memory alone	2			2		
				Question 1 total	8	2	0	10	0	0

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
2	(a)			Medulla oblongata (1)	1			1		
	(b)			Any three (×1) from: - more carbon dioxide / lower blood pH detected by chemoreceptors (1) - cardioacceleratory centre stimulated (1) - impulses along sympathetic neurones (to the SAN) (1) - noradrenaline released (at the SAN) (1) - SAN fires / discharges more frequently (1) Reject adrenaline released by neurones	1	2		3		
	(c)			23.9 (%) (2) Award 1 mark for $(142 - 108) \div 142 \times 100$		2		2	2	
	(d)			Noradrenaline cannot bind to the receptors on the SAN (1) So sympathetic stimulation has less effect and the SAN fires less frequently (1)		2		2		
	(e)			Heart rate increases (1) Acetylcholine from parasympathetic / vagus neurones cannot slow the SAN / the inhibitory effect is removed (1)		2		2		
	(f)			Any one from: intensity / resistance of cycling, time of day, caffeine / food intake before the test, time between taking the drug and cycling, time allowed for heart rate to settle at rest (1) Ignore age or sex (the same volunteers took both treatments)			1	1		1
				Question 2 total	2	8	1	11	2	1

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
3	(a)			X corticotrophin-releasing hormone / CRH (1) Accept vasopressin / ADH Y adrenocorticotrophic hormone / ACTH (1)	2			2		
	(b)			It receives nerve impulses from other parts of the brain (for example the hippocampus) (1) It responds by releasing a hormone (X) that controls the pituitary gland / endocrine glands (1)	1	1		2		
	(c)	(i)		Dexamethasone binds to (glucocorticoid) receptors, acting like high cortisol / negative feedback (1) Less CRH and ACTH are released, so the adrenal glands release less cortisol (1)		2		2		
		(ii)		The tumour releases (high levels of) ACTH that is not controlled by negative feedback (1) So the adrenal glands keep releasing cortisol (1)			2	2		
		(iii)		88.9 (%) (1) Accept 89		1		1	1	
	(d)			Epigenetic change / increased methylation of the glucocorticoid receptor gene (in the hippocampus) (1) Fewer receptors, so negative feedback is weaker and cortisol release is not switched off (1)		2		2		
				Question 3 total	3	6	2	11	1	0

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
4	(a)			P motor cortex (1) Q sensory / somatosensory cortex (1) U visual cortex (1) Reject seeing area	3			3		
	(b)			Occipital lobe (1)	1			1		
	(c)			T (1)	1			1		
	(d)			Each hemisphere receives information from the opposite side / nerve fibres cross over, so the left visual cortex processes the right side of the field of view (1) Touch is processed in the sensory cortex / parietal lobe, which was not damaged (1)		2		2		
	(e)			Receive impulses from the visual cortex / sensory areas (1) Compare with stored memories to give the information meaning / identify the face (1) Accept initiate a response passed to motor areas		2		2		
	(f)			P / motor cortex in the right hemisphere (both needed) (1)		1		1		
				Question 4 total	5	5	0	10	0	0

Question				Marking details	Marks available																																			
					AO1	AO2	AO3	Total	Maths	Prac																														
5	(a)			Fingertip 2.3 (1) Upper back 48.0 (1) Must be to 1 decimal place Example of a full-mark answer<table><tr><th>Site</th><th>Trial 1 / mm</th><th>Trial 2 / mm</th><th>Trial 3 / mm</th><th>Mean / mm</th></tr><tr><td>Fingertip</td><td>2</td><td>3</td><td>2</td><td>2.3</td></tr><tr><td>Lower lip</td><td>4</td><td>5</td><td>4</td><td>4.3</td></tr><tr><td>Palm</td><td>10</td><td>11</td><td>12</td><td>11.0</td></tr><tr><td>Forearm</td><td>36</td><td>39</td><td>42</td><td>39.0</td></tr><tr><td>Upper back</td><td>44</td><td>52</td><td>48</td><td>48.0</td></tr></table>	Site	Trial 1 / mm	Trial 2 / mm	Trial 3 / mm	Mean / mm	Fingertip	2	3	2	2.3	Lower lip	4	5	4	4.3	Palm	10	11	12	11.0	Forearm	36	39	42	39.0	Upper back	44	52	48	48.0		2		2	2	
Site	Trial 1 / mm	Trial 2 / mm	Trial 3 / mm	Mean / mm																																				
Fingertip	2	3	2	2.3																																				
Lower lip	4	5	4	4.3																																				
Palm	10	11	12	11.0																																				
Forearm	36	39	42	39.0																																				
Upper back	44	52	48	48.0																																				
	(b)			Independent: site of the skin / area of the body tested (1) Dependent: smallest distance felt as two points / two-point threshold (1)			2	2		2																														
	(c)			Any two (×1) from: • use the same pressure each time (1) • touch both points at exactly the same time (1) • test one point and two points in a random order / sometimes use one point, so the volunteer cannot guess (1) • test in a random order of sites / allow rest between trials (1) • use the same volunteer / blindfold to make sure the volunteer cannot see (1)			2	2		2																														
	(d)			The fingertip has a high density of sensory receptors / touch receptors (1) The fingertip is served by a large area of the sensory cortex (1) So two points very close together stimulate different receptors and are felt as two / the back has few receptors and a small area of cortex, so points must be far apart (1)		3		3																																

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(e)			They carry out very precise / complex / fine movements (for example speech, handling objects) (1) So a large area of the motor cortex controls them (1) Do not credit more motor neurones alone		2		2		
				Question 5 total	0	7	4	11	2	4

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
6	(a)			Patient 1 Broca's area (1) Patient 2 Wernicke's area (1)		2		2		
	(b)			Broca's area: frontal lobe (1) Wernicke's area: temporal lobe (1)	2			2		
	(c)			Arcuate fasciculus (1) It links Wernicke's area to Broca's area, so words that are heard and understood cannot be passed on to be spoken (1)		2		2		
	(d)	(i)		Language / speech is controlled by the left hemisphere / is lateralised to the left (1)			1	1		
		(ii)		To avoid damaging / removing the areas that control language (1)			1	1		
		(iii)		Any two (×1) from: • non-invasive / no injection into an artery (1) • no risk from the drug / anaesthetic / of a stroke (1) • shows exactly which areas are active during language tasks (1) • no ionising radiation / can be repeated (1)		1	1	2		
				Question 6 total	2	5	3	10	0	0

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
7	(a)			Voltage changes / electrical activity of neurones in the cortex (1)	1			1		
	(b)			3 Hz (2) Award 1 mark for a time between spikes of 0.33 s / 3 spikes in 1 s		2		2	2	
	(c)			Epilepsy is abnormal electrical activity (with no change in structure) (1) EEG records changes in electrical activity over milliseconds, but CT shows only structure (1)		2		2		
	(d)			Detects activity only near the surface / in the cortex / cannot locate activity precisely / cannot show structure (1)	1			1		
	(e)			Any two (×1) from: - CT is fast / takes seconds, which matters in an emergency (1) - CT clearly shows bleeding / skull fractures (1) - he could not say whether he had a pacemaker / metal implant, which is unsafe in MRI (1) - MRI needs the patient to lie still in a noisy, enclosed scanner for a long time (1)			2	2		
	(f)			Any two (×1) from: - a strong magnetic field lines up hydrogen nuclei / protons in water molecules (1) - a pulse of radio waves knocks them out of line (1) - as they realign they give out radio signals, which are detected (1) - different tissues give different signals, so a computer builds an image (1)	2			2		
				Question 7 total	4	4	2	10	2	0

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
8	(a)			Active neurones use more oxygen, so more oxygenated blood flows to them (1) Oxyhaemoglobin and deoxyhaemoglobin respond differently in the magnetic field, so the change is detected (1)	2			2		
	(b)			Wernicke's area is active in all three tasks, 1.6 to 1.9 % (1) Because every task involves understanding words (1) Broca's area is active mainly when repeating words aloud, 2.2 % compared with 0.3 to 0.4 % (1) Because it is the motor area that plans speech (1) Max 3		1	2	3		
	(c)			Brains / responses vary between individuals, so a mean of many is more reliable / representative (1)			1	1		1
	(d)			Active cells take up more glucose / FDG, which becomes trapped (1) The radioactive tracer emits positrons, producing gamma rays that are detected, so more radiation comes from active areas (1)	2			2		
	(e)	(i)		3.5 (1)		1		1	1	
		(ii)		fMRI uses no ionising radiation, so there is no increased risk of cancer / it can be repeated safely (1)			1	1		
				Question 8 total	4	2	4	10	1	1

Question				Marking details	Marks available																							
					AO1	AO2	AO3	Total	Maths	Prac																		
9	(a)			Axes labelled with units: x = age at surgery / months; y = mean visual acuity score (1) Suitable linear scales using more than half of the grid (1) All points plotted correctly $\pm$ half a small square (1) Points joined with ruled straight lines (1) Example of a full-mark answer <table><caption>Data points from the example graph</caption><thead><tr><th>Age at surgery / months</th><th>Visual acuity score</th></tr></thead><tbody><tr><td>1</td><td>0.95</td></tr><tr><td>2</td><td>0.90</td></tr><tr><td>3</td><td>0.72</td></tr><tr><td>4</td><td>0.60</td></tr><tr><td>6</td><td>0.42</td></tr><tr><td>9</td><td>0.30</td></tr><tr><td>12</td><td>0.22</td></tr><tr><td>18</td><td>0.18</td></tr></tbody></table>	Age at surgery / months	Visual acuity score	1	0.95	2	0.90	3	0.72	4	0.60	6	0.42	9	0.30	12	0.22	18	0.18		2	2	4	4	3
Age at surgery / months	Visual acuity score																											
1	0.95																											
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3	0.72																											
4	0.60																											
6	0.42																											
9	0.30																											
12	0.22																											
18	0.18																											
	(b)			Visual acuity decreases as the age at surgery increases (1) Steep fall in the first 6 months, from 0.95 to 0.42, then a smaller fall / levels off at about 0.2 (1)			2	2																				

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(c)			Any three (×1) from: - there is a critical period for vision in the first months of life (1) - the visual cortex needs stimulation from the eyes for synapses to form and be strengthened (1) - without light reaching the retina, unused synapses / pathways are pruned (1) - after the critical period the pathways are hard wired, so they cannot be formed later / vision does not fully recover (1)		3		3		
	(d)			The critical period for language is in the first few years / 0 to 5 years (1) Earlier implants stimulate the auditory cortex / language areas while synapses can still form / before pruning / while the brain is most plastic (1)		2		2		
	(e)			Copying the behaviour of another individual (1)	1			1		
				Question 9 total	1	7	4	12	4	3

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
10	(a)			-2.0 (%) / a decrease of 2.0 % (2) Award 1 mark for $(102.1 - 104.2) \div 104.2 \times 100$ Accept -2		2		2	2	
	(b)			Practice caused neuroplasticity / changes in neural pathways (1) New synapses / dendrites / connections formed in the area used for tracking moving objects, so grey matter increased (1) When practice stopped, unused synapses were pruned / weakened, so grey matter decreased (1)		3		3		
	(c)			Likely to be significant (1) The bars for before training and after training do not overlap (1) Accept a statistical test would be needed to confirm			2	2		2
	(d)			Repeated use of the weak arm stimulates undamaged neurones to form new connections / synapses / pathways (1) Repetition strengthens these new synapses / a larger area of the motor cortex takes over control of the arm (1)		2		2		
	(e)			Younger brains have more synapses / less pruning / more plasticity (1)		1		1		
				Question 10 total	0	8	2	10	2	2

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
11	(a)			Identical twins share all of their alleles and have the highest concordance, so genes are involved (1) Concordance in identical twins is not 100 %, so the environment is also involved (1) Non-identical twins and siblings share about half their alleles and have similar concordance (1)			3	3		
	(b)			Influenced by many genes (1)	1			1		
	(c)			Causes epigenetic changes such as methylation of DNA / acetylation of histones (1) This switches genes on or off without changing the base sequence (1)		2		2		
	(d)	(i)		Innate / instinctive (1) Reject inherited	1			1		
		(ii)		It controls the development / connections of the neurones (circuits) that produce courtship behaviour (1)		1		1		
		(iii)		Females recognise and mate with males of the same species (1) So offspring are fertile / gametes and energy are not wasted on hybrids (1) Accept female choice selects the fittest males		2		2		
				Question 11 total	2	5	3	10	0	0

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
12	(a)			So the humidity on each side can become stable / the air above the water and drying agent can reach steady conditions (1)			1	1		1
	(b)			13.1 (3) Award 2 marks for 6.53 + 6.53 Award 1 mark for the expected number = 30 on each side		3		3	3	
	(c)			One degree of freedom; critical value 3.84 (at $p = 0.05$) (1) 13.1 is greater than the critical value / greater than 10.83, so reject the null hypothesis (1) Significant difference: the probability that it is due to chance is less than 0.05 / less than 0.001; the woodlice prefer the humid side (1) ecf from part (b)			3	3		1
	(d)			Woodlice lose water easily / have no waterproof waxy layer (1) Humid places reduce water loss / desiccation (and damp places are often dark, hiding them from predators) (1)		2		2		
	(e)			The counts only show where the woodlice ended up, not how they moved (1) Measure the speed / rate of turning of individual woodlice in dry and humid air (a kinesis if speed or turning rate changes with humidity) (1)			2	2		2
				Question 12 total	0	5	6	11	3	4

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
13	(a)			An inborn / instinctive, rapid, automatic response to a stimulus that is not learned (1)	1			1		
	(b)			Classical conditioning (1) The odour (neutral stimulus) is repeatedly paired with sugar (unconditioned stimulus) (1) The odour becomes a conditioned stimulus that causes proboscis extension, a conditioned response (1)	1	2		3		
	(c)			It is a control, to show that the learning depends on pairing the odour with sugar, not on repeated exposure to the odour (1)			1	1		1
	(d)			111 (%) (2) Accept 110.5 Award 1 mark for $(80 - 38) \div 38 \times 100$		2		2	2	
	(e)			Royal jelly / diet reduces DNA methylation (1) So genes needed for queen development are expressed / not silenced; workers and queens have the same genes but different gene expression (1)		2		2		
	(f)			1800 m (1) 30° to the left of the (direction of the) sun (1)		2		2	1	
				Question 13 total	2	8	1	11	3	1

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
14	(a)			As group size increases, the time each meerkat spends on guard falls, steeply up to about 10 then more slowly (1) So each meerkat has more time for feeding while predators are still spotted (1)		1	1	2		
	(b)			More competition for food / diseases or parasites spread more easily / a large group is more easily seen by predators / subordinates may not breed (1)		1		1		
	(c)			Each animal must remember the rank of the others / which individuals it lost to (1) So it can be submissive to higher-ranking animals without fighting each time they meet (1)		2		2		
	(d)			Pups learn by practice / trial and error / by watching and copying the helpers (1) Advantage: they learn to handle dangerous prey without being stung / safely (1)		2		2		
	(e)			Any two (×1) from: - the hypothalamus activates the sympathetic nervous system (1) - noradrenaline is released (1) - heart rate and ventilation rate increase (1) - more oxygen / glucose reaches the muscles for respiration (1) Reject adrenaline as the neurotransmitter	1	1		2		
	(f)			Honeybees have castes / sterile workers, but subordinate meerkats are fertile and may breed later / bee communication is innate but meerkats learn / meerkat ranks can change (1)		1		1		
				Question 14 total	1	8	1	10	0	0

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
15				Indicative content	3	3	3	9		
				A Dominance and rank A1 Central males win the most fights (7.2) and gain the most matings (68 %); edge males win 0.8 fights and gain 6 % A2 A dominance hierarchy: higher-ranking males are dominant over lower-ranking males and hold the central patches A3 Only 3 of the 16 males gain most of the matings A4 Ritualised displays let males assess each other without fighting A5 So the risk of injury is reduced and energy is saved; the weaker male backs down A6 Males must recognise each other and learn the outcome of earlier encounters						
				B Territory and courtship B1 Each male defends a patch against other males of the same species (a small territory) B2 Holding a central patch gives access to the females that visit the lek B3 Courtship displays and calls let females recognise a male of the same species and sex that is ready to mate B4 Mating within the species gives fertile offspring B5 Displays synchronise mating / stimulate the female B6 Females can compare many males in one place and choose the best quality male						

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
				C Sexual selection and its limits C1 Intra-sexual selection: males compete by fighting, so alleles for large size and strength are passed on C2 Inter-sexual selection: females choose males with the best tail and display C3 Male handicap model: an elaborate tail is costly, so it is an honest signal of good genes / physical attractiveness model C4 Successful males father most offspring, so these alleles increase in frequency over generations C5 This produces sexual dimorphism: males larger and more ornamented than females C6 Natural selection limits the features: conspicuous males are more easily caught by predators and use more energy						
				7-9 marks Indicative content of this level is detailed information from all three lists. The candidate constructs an articulate, integrated account, correctly linking relevant points in a logical sequence. The answer fully addresses the question with no irrelevant inclusions or significant omissions. Scientific conventions and vocabulary are used appropriately and accurately.						
				4-6 marks Indicative content of this level is detailed information from two of the lists, or less detail from all three. The candidate constructs an account correctly linking some relevant points, showing some reasoning. The answer addresses the question with some omissions. Scientific conventions and vocabulary are usually used appropriately and accurately.						
				1-3 marks Indicative content of this level is some information from at least one of the lists, or a little information from more than one. The candidate makes some relevant points, showing limited reasoning. The answer addresses the question with significant omissions. Use of scientific conventions and vocabulary is limited.						

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
				0 marks The candidate does not make any attempt or give a relevant answer worthy of credit.						
				Question 15 total	3	3	3	9	0	0

UNIT 4: VARIATION, INHERITANCE AND OPTIONS, OPTION C
SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	TOTAL MARK	MATHS	PRAC
1	8	2	0	10	0	0
2	2	8	1	11	2	1
3	3	6	2	11	1	0
4	5	5	0	10	0	0
5	0	7	4	11	2	4
6	2	5	3	10	0	0
7	4	4	2	10	2	0
8	4	2	4	10	1	1
9	1	7	4	12	4	3
10	0	8	2	10	2	2
11	2	5	3	10	0	0
12	0	5	6	11	3	4
13	2	8	1	11	3	1
14	1	8	1	10	0	0
15	3	3	3	9	0	0
TOTAL	37	83	36	156	20	16



A Tutor Meets Tutee project

BioWelsh mark scheme BW-A2-OptionC-W1 (MS). Not an official WJEC mark scheme.

