

BIOWELSH WORKSHEET FOR WJEC GCE A LEVEL BIOLOGY
UNIT 4 – VARIATION, INHERITANCE AND OPTIONS
OPTION B MUSCULOSKELETAL ANATOMY: WORKSHEET 1 (BW-A2-OptionB-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 149.

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 hyaline cartilage (1) B yellow elastic cartilage (1) C white fibrous cartilage / fibrocartilage (1)	1	2		3		1
	(b)			Pinna / outer ear / epiglottis (1)	1			1		
	(c)			High proportion of collagen / fine collagen fibres in a smooth matrix (1) Any one from: smooth surface reduces friction (1); compressible so absorbs shock (1)	1	1		2		
	(d)			Cartilage has no blood vessels / is avascular (1) Nutrients / oxygen reach the chondrocytes only by (slow) diffusion through the matrix, so repair is slow (1)		2		2		
	(e)			Dense bundles of collagen give greater tensile strength / it is the strongest type, so it withstands the large forces on the spine (1)			1	1		
				Question 1 total	3	5	1	9	0	1

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
2	(a)			Organic: collagen (1) Inorganic: hydroxyapatite / calcium phosphate (1) Reject calcium alone	2			2		
	(b)			66.7 (%) (2) Award 1 mark for $(10.2 - 3.4) \div 10.2 \times 100$ Accept 67		2		2	2	
	(c)			Bone 2 has lost its mineral / hydroxyapatite and bends, so the mineral makes bone rigid / hard (1) Bone 3 has lost its collagen / protein and snaps, so collagen gives flexibility / tensile strength / stops bone being brittle (1) Hydroxyapatite resists compression and collagen resists tension / the two together make bone strong but not brittle (1)	1	1	1	3		
	(d)			Any two ($\times 1$) from: - type of bone / same bone from the same kind of chicken (1) - concentration / volume of acid (1) - time in acid / temperature of the acid (1) - oven temperature / heating time (1) - drying method before weighing (1)			2	2		2
	(e)			Water content varies / would add mass, so only the mass of solid bone is compared (1)			1	1		1
				Question 2 total	3	3	4	10	2	3

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
3	(a)			J Haversian canal; K lacuna; L canaliculi; N Volkmann canal All four correct = 2 marks Two or three correct = 1 mark	2			2		
	(b)			Two named from: arteriole / venule / blood vessels / lymph vessel / nerve (fibres) (1) Both needed for the mark	1			1		
	(c)			Blood vessels run in the Haversian / Volkmann canals (1) Oxygen / glucose diffuse (out of the vessels) into tissue fluid (1) Canaliculi (containing tissue fluid) link the lacunae to the canal and to each other (1)	1	2		3		
	(d)			240 (µm) (2) Award 1 mark for $60 \div 250 = 0.24 \text{ mm}$		2		2	2	
	(e)			Osteoblasts secrete collagen / the organic matrix (1) And lay down / deposit hydroxyapatite / calcium phosphate, forming a lamella (1)	1	1		2		
				Question 3 total	5	5	0	10	2	0

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
4	(a)			Osteoblasts build bone / lay down bone matrix (1) Osteoclasts break down bone / reabsorb bone matrix (1)	2			2		
	(b)			1.27 (% per month) / $7.6 \div 6$ (1) Accept 1.3		1		1	1	
	(c)			No weight is carried / no load-bearing stress on the bones (1) So osteoblast activity falls / osteoclasts break down bone faster than osteoblasts rebuild it (1)		1	1	2		
	(d)			Loss is reduced from 7.6 % to 2.6 % over six months / about one third of the loss (1) But density still falls, so exercise does not stop bone loss completely (1) Any one from: sample size / number of astronauts not given (1); other factors such as diet not stated (1); only six months studied (1)			3	3	1	1
	(e)			Breakdown of bone matrix / hydroxyapatite releases calcium ions into the blood (1) Bone is the body's calcium store, so the excess calcium is excreted by the kidneys (1)		1	1	2		
				Question 4 total	2	3	5	10	2	1

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
5	(a)			109 (%) (2) Award 1 mark for $(71 - 34) \div 34 \times 100$ Accept 108.8		2		2	2	
	(b)			Vitamin D is highest in late summer and lowest in late winter (1) More / stronger sunlight / UV and longer days in summer, so more vitamin D is made in the skin (1)		1	1	2		
	(c)			Vitamin D is needed to absorb calcium from the gut / small intestine (1) Less calcium / hydroxyapatite is laid down in the bone matrix (1) So the growing bones are soft / weak and bend / bow under the body's weight (1)	2	1		3		
	(d)			Osteomalacia occurs in adults / after bones have stopped growing, rickets in children (1)	1			1		
	(e)			Eat more oily fish / eggs / take vitamin D supplements, to increase calcium absorption; OR eat more dairy products for more calcium to increase bone density (1)			1	1		
				Question 5 total	3	4	2	9	2	0

Question				Marking details	Marks available																				
					AO1	AO2	AO3	Total	Maths	Prac															
6	(a)			Patient T (1) Abnormal / rapid loss of bone density / bone mass (1)	1	1		2																	
	(b)			Vertebrae have fractured / collapsed / become compressed (1) So the thoracic spine curves forwards / kyphosis (1)		1	1	2																	
	(c)			Oestrogen falls, and oestrogen normally reduces osteoclast activity, so more bone is broken down (1)		1		1																	
	(d)			Axes correct way round and labelled with units: x = time / years; y = mean change in density / % (1) Suitable linear scales, including negative values, using more than half of the grid (1) All points plotted correctly $\pm$ half a small square (1) Points joined with ruled straight lines and each line labelled (1) Example of a full-mark answer <table><caption>Data points from the example graph</caption><thead><tr><th>Time since start of treatment / years</th><th>Mean change in hip bone density / % (Drug)</th><th>Mean change in hip bone density / % (Placebo)</th></tr></thead><tbody><tr><td>0</td><td>0</td><td>0</td></tr><tr><td>1</td><td>2.8</td><td>-0.8</td></tr><tr><td>2</td><td>4.1</td><td>-1.8</td></tr><tr><td>3</td><td>4.9</td><td>-2.6</td></tr></tbody></table>	Time since start of treatment / years	Mean change in hip bone density / % (Drug)	Mean change in hip bone density / % (Placebo)	0	0	0	1	2.8	-0.8	2	4.1	-1.8	3	4.9	-2.6		2	2	4	4	2
Time since start of treatment / years	Mean change in hip bone density / % (Drug)	Mean change in hip bone density / % (Placebo)																							
0	0	0																							
1	2.8	-0.8																							
2	4.1	-1.8																							
3	4.9	-2.6																							

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(e)			The drug reduces osteoclast activity, so less bone is broken down (1) Osteoblasts still build bone, so density increases with the drug but continues to fall with the placebo (1)		1	1	2		
	(f)			An inherited mutation in a gene for collagen, so collagen is faulty / too little is made, making the bone brittle (1)	1			1		
				Question 6 total	2	6	4	12	4	2

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
7	(a)			P nucleus (1) Q muscle fibre / muscle cell (1) Reject myofibril for Q	2			2		1
	(b)			It is formed by the fusion of many (embryonic) cells (1)	1			1		
	(c)			Sarcolemma (1) Sarcoplasmic reticulum (1)	2			2		
	(d)			Myofibrils contain (repeating) sarcomeres / alternating dark A bands and light I bands (1) The sarcomeres / bands of adjacent myofibrils are lined up (1)		2		2		
	(e)			Fast twitch (1) Few mitochondria means they respire mainly anaerobically / many myofibrils give fast, powerful contraction (1)		1	1	2		
				Question 7 total	5	3	1	9	0	1

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
8	(a)			E sarcomere; F A band; G H zone; H I band All four correct = 2 marks Two or three correct = 1 mark	2			2		
	(b)			Y (1) Position 3 is in the H zone, where there are only thick / myosin filaments (1)		1	1	2		
	(c)			Actin / thin filaments slide over / between the myosin towards the M line (1) Region F / the A band stays the same length because the myosin filaments do not change length (1) Region G / the H zone gets shorter (or disappears) because the actin filaments move further into it (1)	1	2		3		
	(d)			24 (%) (2) Award 1 mark for $(2.5 - 1.9) \div 2.5 \times 100$		2		2	2	
	(e)			At U there is no overlap between actin and myosin, so no cross-bridges can form (1) At T the overlap allows the largest number of myosin heads to bind to actin / form cross-bridges (1)		1	1	2	1	
				Question 8 total	3	6	2	11	3	0

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
9	(a)			Y W Z V X All correct = 2 marks One pair of letters swapped = 1 mark	2			2		
	(b)			Fewer calcium ions released, so fewer bind to troponin (1) Tropomyosin stays over / is not moved from the binding sites on actin (1) Fewer cross-bridges / myosin heads bind to actin, so less force / no contraction (1)		3		3		
	(c)			ATP binds to the myosin head, causing it to detach from actin / breaking the cross-bridge (1) ATP is hydrolysed by myosin ATPase (1) Releasing energy that returns / re-cocks the myosin head, ready to bind further along the actin (1) Accept ATP used to pump calcium ions back into the sarcoplasmic reticulum	2	1		3		
	(d)			No more ATP is made (as respiration stops) (1) So myosin heads cannot detach from actin / cross-bridges cannot break (1)		1	1	2		
				Question 9 total	4	5	1	10	0	0

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
10	(a)			1 : 3.2 (2) Award 1 mark for fast twitch = 76 % Accept 1 : 3.17		2		2	2	
	(b)			The samples contained different total numbers of fibres, so percentages allow a fair comparison (1)			1	1		1
	(c)			More myoglobin / more capillaries / a greater blood supply (1) Myoglobin stores oxygen / more oxygen is delivered (1) So aerobic respiration can continue for a long time, and the fibres fatigue slowly / suit endurance (1)	1	2		3		
	(d)			Creatine phosphate transfers its phosphate to ADP (1) Making ATP quickly / without oxygen, for short bursts (1)	1	1		2		
	(e)			The sprinter's (fast twitch) fibres respire anaerobically, so lactate / lactic acid builds up (1) The marathon runner's fibres respire aerobically, using glycogen and later protein / fat, so little lactate is made / ATP supply continues (1)			2	2		
				Question 10 total	2	5	3	10	2	1

Question				Marking details	Marks available																	
					AO1	AO2	AO3	Total	Maths	Prac												
11	(a)			W displaced (transverse) fracture (1) Y comminuted fracture (1) Z greenstick fracture (1)	2	1		3														
	(b)			Children's bones contain relatively more collagen / less mineral, so they are more flexible and bend rather than snap (1)			1	1														
	(c)			radius appendicular; clavicle pectoral girdle; sternum axial and ribcage / thorax All four cells correct = 2 marks Two or three cells correct = 1 mark Example of a full-mark answer<table><tr><td>Bone</td><td>Axial or appendicular</td><td>Part of the skeleton</td></tr><tr><td>radius</td><td>appendicular</td><td>forelimb</td></tr><tr><td>clavicle</td><td>appendicular</td><td>pectoral girdle</td></tr><tr><td>sternum</td><td>axial</td><td>ribcage / thorax</td></tr></table>	Bone	Axial or appendicular	Part of the skeleton	radius	appendicular	forelimb	clavicle	appendicular	pectoral girdle	sternum	axial	ribcage / thorax	2			2		
Bone	Axial or appendicular	Part of the skeleton																				
radius	appendicular	forelimb																				
clavicle	appendicular	pectoral girdle																				
sternum	axial	ribcage / thorax																				
	(d)			Bacteria can enter through the broken skin, so there is a high risk of infection (of the bone) (1)		1		1														
	(e)			The broken ends are realigned / put back in line (1) And held in place with metal plates / screws / pins / rods (while osteoblasts lay down new bone) (1)	1	1		2														
				Question 11 total	5	3	1	9	0	0												

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
12	(a)			Two named from: support / protects the spinal cord / allows flexibility / movement / muscle attachment / attachment of ribs (1) Both needed for the mark	1			1		
	(b)			A cervical (1) Transverse foramina / holes in the transverse processes / small body / (bifid) short spinous process (1) B lumbar (1) Very large / thick body / short thick processes / no facets for ribs (1)		4		4		
	(c)			Large body to bear / support the (large) weight of the body above (1) Large processes for attachment of the powerful back muscles (1)		2		2		
	(d)			Scoliosis (1) Any two from: brace (while still growing) (1); physiotherapy / exercises to strengthen the back muscles (1); surgery to straighten the spine / insert rods (1); monitoring (1)	1	1	1	3		
				Question 12 total	2	7	1	10	0	0

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
13	(a)			P articular / hyaline cartilage; Q synovial membrane; R ligament; S synovial fluid All four correct = 2 marks Two or three correct = 1 mark	2			2		
	(b)			Any two (×1) from: • lubricates / reduces friction (1) • absorbs shock (1) • supplies nutrients / oxygen to the cartilage / removes waste (1)	1	1		2		
	(c)			Knee hinge; hip ball and socket (1) Both needed	1			1		
	(d)			The joint space is narrowed / almost absent (1) Because the articular cartilage has worn away / bone surfaces are rough / bone spurs (1)			2	2		
	(e)			The immune system attacks the body's own tissue / treats proteins in the joint as antigens (1) Synovial membrane (1)	1	1		2		
	(f)			Any two (×1) from: • damage / loss of cartilage is severe and cannot be repaired (1) • drugs only relieve pain / inflammation, not the cause (1) • replacement restores mobility / reduces pain (1) • improves quality of life / allows the patient to exercise (1)			2	2		
				Question 13 total	5	2	4	11	0	0

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
14	(a)			Elbow (joint), which acts as the fulcrum (1)	1			1		
	(b)			Third order (1) The effort (biceps) is between the fulcrum (elbow) and the load (kettle) (1)	1	1		2		
	(c)			110 (N) (3) Award 2 marks for effort $\times 4 = 14.7 \times 30$ Award 1 mark for load $= 1.5 \times 9.8 = 14.7 \text{ N}$ Accept 110.25		3		3	3	
	(d)			The muscle shortens only a little, but the hand moves a large distance / quickly (1)			1	1		
	(e)			The triceps contracts and pulls on the ulna / behind the elbow (1) The biceps relaxes (and is stretched); they are an antagonistic pair because muscles can only pull (1)	1	1		2		
	(f)			All the force of contraction is transmitted to the bone / no energy is lost in stretching the tendon (1)	1			1		
				Question 14 total	4	5	1	10	3	0

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
15				Indicative content	3	3	3	9		
				A Compact bone and its maintenance A1 Matrix about 30 % collagen (organic) and 70 % hydroxyapatite / calcium phosphate (inorganic) A2 Collagen gives flexibility / tensile strength; hydroxyapatite gives hardness / resists compression A3 Built of Haversian systems: lamellae around a Haversian canal with blood vessels; lacunae and canaliculi A4 Osteoblasts lay down new matrix / hydroxyapatite; osteoclasts break down matrix, releasing calcium A5 Bone is constantly remodelled; in a healthy adult building and breaking down are balanced						
				B The pattern in Graph 15.1 and osteoporosis B1 Fractures rise steeply with age in both sexes, especially after 70 B2 Rate is higher in women at every age; for example 29 compared with 17.5 per 1000 at 90 B3 Osteoporosis: abnormal loss of bone density as osteoclasts break down bone faster than osteoblasts rebuild it B4 Oestrogen falls after the menopause; oestrogen normally reduces osteoclast activity, so women lose bone faster B5 Men reach a higher peak bone mass, so they fall below the fracture threshold later B6 Less dense / thinner bone breaks after minor falls, and falls become more likely with age						

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
				C Treatment and prevention C1 Diagnosed by X-ray; displaced fractures realigned C2 Usually surgery quickly, fixing the bone with metal pins / screws / rods / plates or a hip replacement C3 Early surgery allows mobility sooner, avoiding complications of immobility such as deep vein thrombosis / pneumonia / muscle wasting C4 Prevention: weight-bearing exercise, calcium and vitamin D, drugs that reduce osteoclast activity, stopping smoking C5 Preventing falls, as each fracture is dangerous for older people						
				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 B
SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	TOTAL MARK	MATHS	PRAC
1	3	5	1	9	0	1
2	3	3	4	10	2	3
3	5	5	0	10	2	0
4	2	3	5	10	2	1
5	3	4	2	9	2	0
6	2	6	4	12	4	2
7	5	3	1	9	0	1
8	3	6	2	11	3	0
9	4	5	1	10	0	0
10	2	5	3	10	2	1
11	5	3	1	9	0	0
12	2	7	1	10	0	0
13	5	2	4	11	0	0
14	4	5	1	10	3	0
15	3	3	3	9	0	0
TOTAL	51	65	33	149	20	9



A Tutor Meets Tutee project

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

