WJEC (Wales) Biology A-level Option 4.B: Human Musculoskeletal Anatomy Questions by Topic - Mark Scheme

1.

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
1	(a)	(i)		Transverse section		1		1		1
		(ii)		A – {I band/ Actin only} as it only contains thin filaments B – {H zone/ myosin only} as it contains thick filaments only C - outer edge/dark region of A band as it shows overlap of thick anc {thin filaments/ actin and myosin} Accept labelled on diagram for location		3		3		
		(iii)		**Any 4 (x1) from:** A. Ca^{2+} ions bind to troponin changing its shape B. moves tropomyosin, exposing binding sites on actin (1) C. Myosin heads make cross bridges to actin by binding to these sites (1) D. ADP and Pi are released causing the myosin head to bend (1) E. ATP joins to myosin head breaking the cross bridge to actin(1) F. Actin filaments slide along myosin (by ratchet mechanism) (1)	4			4		
	(b)	(i)		Myofibril diameter could vary between individuals and within an individual in different muscles			1	1		1
		(ii)		less force generated)(1) Any **one** (x1) from In post-flight muscle the actin and myosin have bigger spaces between them Actin has been broken down/less actin {Fewer cross bridges can form/ less myosin bound to actin}		1	1	2		
	(c)	(i)		C because the patient is younger/ could be more active (1) D (has osteoporosis,) making new bone growth more difficult/ osteoblasts less active (1)			2	2		
		(ii)		Patient will be mobile more quickly **and** this promotes healing/ reduced complications with blood clots/pressure sores/ less muscle wastage/ DVT	1			1		
	(d)	(i)		Biceps – third order **and** Triceps – first order	1			1		
		(ii)		When bicep flexes Effort is between Fulcrum and Load/ effort in middle (1) When tricep flexes Fulcrum is between Load and Effort/ fulcrum in middle (1)		2		2		
		(iii)		Same length arms/age/type of exercise/gender			1	1		1
		(iv)		F = 25N = 2 marks If incorrect allow 1 mark for sight of $\frac{2.5 \times 50}{5}$ $F_1 \times 5 = 50 \times 2.5$		2		2	2	
				Question 1 total	6	9	5	20	2	3

2.

Question			Marking details	Marks Available
2	*(a)*		anaerobic respiration; lactate/lactic acid produced; accumulates in muscle/not removed into blood rapidly enough; low pH in muscle; enzymes less effective; exhaustion of energy glycogen;	3 max
	(b)		endurance events are aerobic; oxygen debt does not develop; little anaerobic respiration; no lactate/lactic acid; maximum energy; from fat/glycogen; longer to reach fatigue; improved blood supply;	3 max
	(c)	(i)	improves supply of oxygen; improves removal of carbon dioxide; improves removal of lactic acid; decreases diffusion distance; increases surface area for exchange;	2 max
		(ii)	increase in number/size of mitochondria; increase in enzymes of Krebs cycle; increase in size of muscle fibres; increase in ETC molecules; increase in myoglobin	2 max
			Question 2 Total	**[10]**

3. (a) (i) sarcomere [1]

(ii) J – H zone and K – A band [**not:** zone or region] [1]

(iii) J shorter / decrease and K same length. [1]

(b) A band == maximum overlap of actin and myosin;

(because) actin slides past myosin;

Z-lines to move closer;

H zone disappears when actin filaments meet. [3]

4.

Question		Marking details	Marks Available
(a)	(i)	A= Myofibril; B = Z line; C = mitochondrion / accept T system; D = sarcomere;	4
	(ii)	I band A band Both for 1 mark	1
	(iii)	Glycogen;	1

(b)

Band	increase	decrease	same
I	×	✓	×
A	×	×	✓
H	×	✓	×

3

(c)

Slow	Fast
More ATP	Less ATP
Contract longer time	Short burst contraction
Fire slowly	Fire rapidly
aerobic	anaerobic
Fatigue slowly	Quickly fatigue
Good blood supply	Poor blood supply
High numbers mitochondria	low numbers mitochondria
More myoglobin	Less myoglobin
Low density myofibrils	high density myofibrils
Small diameter	Large diameter
Low resistance to lactic acid	High resistance to lactic acid

4

(d) Detaching myosin bridge from actin binding site; Max 2
Return of myosin head to original position;
Pumping Ca^{2+} back into sarcoplasmic reticulum;
Creation of creatine phosphate from creatine;

Question 4 Total **[15]**

5.

Question		Marking details	Marks Available
5			
(b)	(i)	Actin;	1
	(ii)	Correct on diagram;	1
	(iii)	ADP, iP;	1
	(iv)	Allows cross bridges to form/ owtte; Clubbed head of myosin moves back and forth/ owtte; Ratchet mechanism;	3

(c) 4

Slow Twitch	Fast Twitch
Good blood supply	Poor blood supply
High numbers mitochondria	Low numbers mitochondria
More myoglobin	Less myoglobin
Low density myofibrils	High density myofibrils
Small diameter myofibrils / fibres	Large diameter myofibrils / fibres
Low glycogen levels	High glycogen levels
aerobic / no lactic acid / low lactate tolerance	Anaerobic / lactic acid / high tolerance to lactate
Slow contraction / weak force / fatigue slowly / endurance.	Quick contraction / strong force / fatigue quickly / speed.

Question 5 Total **[10]**

6.

Question			Marking details	Marks Available
6	*(a)*	(i)	Myosin / thick filaments and actin / thin filaments;	1
		(ii)	A H zone; B I band;	2
		(iii)	transmit action potential / nerve impulse into centre of fibre; so that all myofibrils contract at same time; OR Increased surface area; For increased diffusion;	2
	(b)	(i)	Heart rate goes up / increased blood supply / greater rate and depth of ventilation;	1
		(ii)	Any **2** from: Anaerobic respiration; glycolysis and glucose to pyruvate; pyruvate reduced to lactate by reduced NAD / $NADH_2$.	2
		(iii)	Any **1** from: Muscle fatigue / cramp; pH lowers; increased dissociation of oxyhaemoglobin / Bohr effect;	1
			Question 6 Total	**[9]**

7.

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
7	(a)	(i)		X = Haversian canal (1) O_2 delivery/ CO_2 removal / nutrients/ named nutrients(1) Accept reference to nerves and pain	2			2		1
		(ii)		Organic: 30 Inorganic: 70	1			1		
	(b)			• osteoblast {lays down/ secrete} the matrix/ ossification of bone (1) Accept components of matrix • osteoclasts break bone down (1) • BMD increases with Denosumab/ less fractures with Denosumab (1) • therefore breakdown not taking place /osteoblasts more active than osteoclasts(1)	1	1 1 1		4		
	(c)			Denosumab (1) treatment with denosumab reduced the risk fractures by 55-70 % / treatment with oestrogen only 35 % (1)			2	2	1	1?
	(d)	(i)		Realignment + {Immobilisation with cast or splint) / Surgery with pins or plates }		1		1		
		(ii)		T- Score:= -2.41 Accept -2.4		1		1	1	1?
		(iii)		Osteopenia (1) Fracture Risk: Moderate Risk (1)			2	2		
	(e)	(i)		Wrist is a gliding joint (1) wide range of movement/ moves in more than one plane (1) finger is hinge joint (1) bends and straightens/ movement in one plane(1)	1 1	1 1		4		
		(ii)		Rheumatoid (1) auto-immune disease (1) involving an {inflammatory response/ increased blood supply to the joint/ ORA for osteoarthritis (1)		2	1	3		
				Question 7 total	**6**	**9**	**5**	**20**	**2**	**3**

8.

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
8	*(a)*	(i)		A Humerus B Radius C Ulna **All three** correct = 1 mark	1			1		
		(ii)		It reduces friction in the joint/ stops rubbing. (1) The joint moves in one plane only / (it is a hinge joint) so the forearm can **only** {move up / flex} **and** {down / extend} in relation to the humerus. (1) NOT one direction	2			2		
		(iii)		Hyaline cartilage has collagen fibres **and** yellow elastic cartilage has elastin fibres. (1) Yellow elastic cartilage {more flexible than hyaline cartilage / maintains shape} (1) Hyaline cartilage is firmer/ tougher and can withstand forces in the joint. (1)	1	2		3		
		(iv)		It has no blood vessels + so nutrients are acquired by diffusion.		1		1		
	(b)	(i)	I	167.9 or 167.86 or 168 = 2 marks $\frac{750-280}{280} \times 100$ = 1 mark		2		2	2	
			II	Vitamin D deficiency in the diet/ increased use of sunblock/ children spend less time outside. (1)	1			1		
		(ii)		Not all rickets sufferers will seek medical attention/ misdiagnosis/ data for under 5s only/ cases unreported			1	1		1
		(iii)		Any **two** (×1) from Similar/ same ages (1) Similar/ same ethnic groups/skin tone (1) Similar/ same exposure to sunlight (1) Similar/same diets (1) Proportion of males/ females (1) **Ethics:** not giving vitamin D supplement to children makes them more likely to develop rickets.			2 1	3		2
		(iv)		Osteomalacia **and** Adult bones have stopped growing	1			1		
	(c)	(i)		Limited ATP in muscle, ATP used first/ quickly. (1) Creatine phosphate then used to phosphorylate ADP to provide ATP/ replenish the store of ATP. (1) Aerobic respiration takes over from anaerobic respiration because lactate builds up/ produces more ATP. (1)		3		3		
		(ii)		more suitable for sprinting/ short distances			1	1		
		(iii)		Flat {feet/foot} **and** treat using {special shoes/ exercise/surgery/ physiotherapy}. (1)		1		1		
				Question 8 total	**6**	**9**	**5**	**20**	**2**	**3**

9.

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
9	(a)	(i)		<table><tr><th></th><th>Actin</th><th>Myosin</th><th>Troponin</th><th>Tropomyosin</th></tr><tr><td>A Band</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr><tr><td>I Band</td><td>✓</td><td></td><td>✓</td><td>✓</td></tr></table> (1 mark per correct row)	2			2		
		(ii)		Any 2 x (1) from: Myosin head binds to actin/cross bridges form between actin and myosin (1) Myosin head {bends/tilts/ power stroke} so actin is pulled past the myosin(1) Detail of ATP involvement in release of head (1)	2			2		
	(b)	(i)		Calculate a mean to improve reliability / Identify that there were a range of sarcomere lengths (1)			1	1		
		(ii)		1.2 µm = 3 marks 1.2 (no units) = 2 marks (3.6-1.2) / 2 = 1 mark		3		3	3	
		(iii)		Any 2 x (1) The temperature of solution (1) pH of solution (1) same type of muscle (1) Same concentration solution (1) OR 2 controlled variables without solution (1)			2	2		2
		(iv)		Any 2 x (1) from: • no overlap between actin and myosin filaments (1) • no cross-bridges form / no possibility of myosin head moving actin (1) • no contraction possible / sarcomeres cannot get shorter (1)			2	2		
	(c)	(i)		each muscle contracts to 'pull' in each direction / as one contracts the other relaxes to move the limb (1)	1			1		
		(ii)		Any 2 x (1) from: Quadriceps contract (1) The osteoarthritic group has a lower contraction force ORA (1)	1	1		2		
		(iii)		Any 5 x (1) from: A. BMI states they are obese / heavier mass to be moved by quadriceps (1) B. Reference to BMI and the effect on contraction force/ stair climb (1) C. Exercise reduces BMI/ mass(1) D. Exercise strengthens the quadriceps (1) E. supports the joint/ strengthens muscles around the joint (1) F. increases flexibility of the joint / stimulates cartilage growth /reduces joint stiffness (1)		5		5		
				Question 9 total	**6**	**9**	**5**	**20**	**3**	**2**

10.

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
10	(a)	(i)		Femur	1			1		
		(ii)		M=66 or 67/150 (1) = 0.44 or 0.4 / 0.45 or 0.5 (1)		2		2	2	
		(iii)		hydroxyapatite / calcium ions **and** phosphate ions / calcium phosphate (1)	1			1		
		(iv)		Any **two** × (1) from: • {Haversian/Volkmann} canals contain blood vessels (1) • Diffusion of (named substance/O_2/glucose/amino acids) to {osteoblasts/osteoclasts/ cells} (1) • Canaliculi contains {fluid for exchange with the cells/ tissue fluid} (1)	2			2		
		(v)		Slow fibres are {red /darker} **and** fast fibres are {white/lighter} (1) {Increased blood supply to/ more blood in} slow twitch fibres / Increased myoglobin in slow twitch fibres/ ORA for fast twitch fibres (1)			2	2		
		(vi)		Total number of fibres in each sample {varied/different} (1) Allows comparison (between different athletes) (1)		2		2		2
		(vii)		the activity type is the only variable that changes/ owtte		1		1		1
		(viii)		{High/ 70} % fast twitch (1) Anaerobic respiration (1) Because there are short intense bursts of activity (1)		1	2	3		
	(b)	(i)		Flexibility / support / protection of spinal cord/ attachment of ribs **Any 2 for 1 mark**	1			1		
		(ii)		Thoracic		1		1		
		(iii)		Physiotherapy / weight loss / Exercise to strengthen muscles/ or example		1		1		
	(c)	(i)		Ball and socket joint	1			1		
		(ii)		Osteoarthritis (1) reduced joint space / reduced cartilage / inflammation /swelling (1)		1	1	2		
				Question10 total	**6**	**9**	**5**	**20**	**2**	**2**

11.

Question Option B				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
11	(a)		(i)	cartilage (1) Chondrocytes (1)	2			2		
			(ii)	Compact (bone) **and** Calcium phosphate/hydroxyapatite (1)	1			1		
	(b)		(i)	Osteoblasts – build up bone **and** Osteoclasts – break down bone (1)	1			1		
			(ii)	Oestrogen would decrease osteoclast activity/bring osteoclast activity to normal level/reduce loss calcium from bones(1) Less bone broken down (1)			2	2		
			(iii)	Vitamin D supplements/Calcium supplements (1) increases calcium absorption (in the gut)/increase bone formation (1)		2		2		
			(iv)	10 yr old girls have same BMD as 10 yr olds with TS (1) Difference between normal and TS not obvious til 12+ years (1)			2	2		1
			(v)	Compares the result with the mean/Shows how far the value is from the mean		1		1		1
			(vi)	Bone realignment/immobilisation (in a cast or splint)	1			1		
			(vii)	Less calcium ions bind to troponin so no shape change (1) (No shape change results in) less tropomyosin being moved (1) Exposing less myosin binding sites (on the actin) (1) Resulting in less force exerted (1)		3	1	4		
	(c)		(i)	Third (order lever)	1			1		
			(ii)	333.2/333 =2 marks 39.2 x (34/4) (1)		2		2	2	
			(iii)	Age of the patients/other health issues/general fitness		1		1		1
				Question 11 Option B total	**6**	**9**	**5**	**20**	**2**	**3**