

WJEC (Wales) Biology A-level
Topic 3.7: Homeostasis and the
Kidney
Questions by Topic - Mark
Scheme

1.	Question	Marking details	Marks Available
1	(a)	(i) A Collecting duct; B Proximal Convoluted Tubule; C Distal Convoluted Tubule;	3
		(ii) Label to Glomerulus capillary/centre of Bowman's capsule; Label to PCT;	2
	(b)	Both for one mark X Renal artery Y Renal vein;	1
	(c)	Water leaves descending limb {osmotically/by osmosis}/ Na ⁺ is retained in descending limb; At apex Na ⁺ is very concentrated/ the ascending limb receives a filtrate rich in Na ⁺ /OWTTE; Na ⁺ {actively transported/pumped out} of the ascending limb; Lowering the water potential in the medulla; Ascending limb {does not allow the escape of water/ impermeable to water}; Counter current system = neutral	Max 4
	(d)	{High osmotic pressure /low water potential/ low solute potential/ high solute concentration} of <u>blood</u> detected by { osmoreceptors/hypothalamus }; (Secretion of) ADH by pituitary; Reject: anterior pituitary Causes collecting duct (walls) to {become more permeable to water/insertion of aquaporins}; Water moves into the medulla by osmosis; (Quickly) removed by the {Vasa Recta/capillaries/ blood}; <u>Low volumes of concentrated</u> urine produced;	Max 4
Question 1 Total			[14]

2.

Question			Marking details	Marks Available
2	(a)		maintenance/control of internal environment; at set point/constant/stable; despite external changes;	2 max
	(b)		hypothalamus; Posterior; Pituitary; ADH; Collecting duct walls/ distal convoluted tubules; Increases/ rises/ high;	6
			Question 2 Total	[8]

3.

- (a) (i) glomerulus [1]
- (ii) urea, amino acids, fatty acids / glycerol / small proteins /
inorganic ions / salt (name two for 1 mark) [1]
- (iii) ultrafiltration [1]
- (iv) blood pressure decreased; less filtrate formed [2]
- (b) (i) loop of Henle [1]
- (ii) increased length / longer [1]
[not: larger]
- (c) (i) fish – ammonia
bird – uric acid
mammal – urea [3]
- (ii) uric acid [1]
- (iii) little mass for storage in eggs / light for flight **[not: less toxic]** [1]

[Total 12 marks]

4.

Question

Marking details

Marks
Available

- 4 (a)
- Low water levels in blood/high osmotic potential/low Ψ ;
 - Detected by osmoreceptors;
 - In hypothalamus;
 - (More) ADH secreted from (posterior lobe of) pituitary;
 - {Into/travels in} blood to;
 - {collecting duct/distal convoluted tubule}{ becomes more permeable/more aquaporins/ more water channels in membranes};
 - Water absorbed;
 - Because of low Ψ in medulla;
- (b) (i) As plasma solute concentration increases to 282 there is no increase in ADH/ the concentration of ADH remains constant; 2
After 282 there is {a proportional/ rapid} increase in ADH; (increase must be qualified)
- (ii) (Up to 293 au) ADH can achieve sufficient water reabsorption/ OWTTE; 2
After this point {water needs to be taken in/ by drinking} to avoid dehydration;
- (c) Blood loss/vomiting; NOT dehydration/ anaemia 1

Question 4 Total

[11]

5.

Question			Marking details	Marks Available						
5	(a)		<table><tr><td>A</td><td>Cortex</td><td>Presence of Bowman's capsule / Glomerulus / renal capsule;</td></tr><tr><td>B</td><td>Medulla</td><td>(Sections of) collecting ducts / (Only sections of) loops of Henle / collecting ducts;</td></tr></table> 1 mark for each correct row	A	Cortex	Presence of Bowman's capsule / Glomerulus / renal capsule;	B	Medulla	(Sections of) collecting ducts / (Only sections of) loops of Henle / collecting ducts;	2
	A	Cortex	Presence of Bowman's capsule / Glomerulus / renal capsule;							
B	Medulla	(Sections of) collecting ducts / (Only sections of) loops of Henle / collecting ducts;								
	(b)		Any 5 from: 1. Mention of glomerulus + Bowman's capsule;	5						

			2. Glomerulus has a high hydrostatic / blood pressure; 3. Because afferent arteriole / blood vessel is wider diameter than efferent; 4. Glomerulus <u>capillaries</u> have many small holes / fenestrations / are leaky; 5. Some correct reference to basement membrane acting as a dialysing membrane eq; 6. Allowing {small molecules / plasma minus the large proteins} to squeeze through; 7. Correct reference to function of podocytes / filtration slits;	
	(c)		Any 3 from: <i>Protein controlled diet</i> High protein means (more) urea which cannot be removed; Accept High protein intake makes the blood more acidic (uric acid); <i>Low sodium chloride</i> Excess Salt does not need to be removed; High salt causes high blood pressure / Fluid retention / oedema;	3
5	(d)	(i)	A Collecting duct; C (posterior lobe) Pituitary gland; NOT anterior	2
		(ii)	Any 2 for 1 mark High solute intake or e.g. / Sweating / Low water intake / Vomiting / Diarrhoea; dehydration = neutral	1
		(iii)	Increased permeability of the collecting duct to water / more aquaporins / water channels so more water flows into the medulla (by osmosis);	1
			Question 5 Total	[14]

6.

Question			Marking details	Marks Available
6	(a)	(i)	Any 2 from: facilitated diffusion / through proteins; down concentration gradient / high conc. to low concentration; passive / no energy required;	2
		(ii)	Any 3 from: Osmosis; High water potential to low water potential; partially permeable membrane; No energy required / no ATP	3
		(iii)	Facilitated diffusion into cell from glomerular filtrate; Sodium potassium pump; Active transport / ATP used;	3
		(iv)	facilitated diffusion / through proteins; glucose and amino acids diffuse with sodium ions; glucose and amino acids diffuse + glucose actively transported from PCT cells into blood;	3
	(b)		Any 3 from: More sodium and glucose absorbed from gut into blood; more glucose and sodium ions in glomerular filtrate; more sodium ions diffuse into PCT cell <i>because of higher conc. gradient</i> ; more glucose co-transported; lowers water potential, more water reabsorbed by osmosis; reference Loop of Henle / collecting ducts qual:	3
Question 6 Total				[14]

7.	(iv)	Effector: left dotted line- makes more permeable right dotted line- makes less permeable	1
		Concentration: left dotted line- increase/ hypertonic right dotted line- decrease/ hypotonic	1
		volume : left dotted line- decrease right dotted line- increase	1
(d) (i)	(I) freshwater fish release ammonia; (II) <u>insects</u> release uric acid.	1 1	
(ii)	<u>requires</u> less water for its disposal to allow them to survive in dry places. / <u>avp</u> e.g. less toxic/less mass to allow flight	1	
			Total 15 marks

(iv)	Effector: left dotted line- makes more permeable right dotted line- makes less permeable	1
	Concentration: left dotted line- increase/ hypertonic right dotted line- decrease/ hypotonic	1
	volume : left dotted line- decrease right dotted line- increase	1
(d) (i)	(I) freshwater fish release ammonia; (II) <u>insects</u> release uric acid.	1 1
(ii)	<u>requires</u> less water for its disposal to allow them to survive in dry places. / <u>avp</u> e.g. less toxic/less mass to allow flight	1
		Total 15 marks

8.	Question	Marking details	Marks Available	Questi
8	(a) (i) Water absorbed into blood, water potential rises; Osmoreceptors hypothalamus; (Posterior) pituitary, releases less ADH; R anterior pituitary DCT/ collecting duct, less permeable; Less water reabsorbed, large volumes dilute urine produced;		Max 4	(c)
	(ii) Same/ less salt but in a greater volume of urine/ Owtte;		1	
	(iii) Age; Sex; Activity levels / exterior temperature; Diet/ salt intake; Previous fluid intake; mass/weight; external temperature; normal kidney function;		Max 2	
(b)	(i) Efferent arteriole narrower than afferent/ ORA/ ventricular systole;		1	
	(ii) Protein;		1	
	(iii) Down water potential gradient; Osmosis		2	
	(iv) 10 – 6.7; 3.3kPa;		2	
(c)	(i) (circular) muscles contract, lumen gets smaller / ORA; Less difference between afferent and efferent diameter therefore pressure drops;		2	
	(ii) Increased glomerular filtration, dehydration/ increased vol. Urine / damage kidney;		1	
	Question 8 Total		[16]	

9.

Question	Marking details	Marks Available
(a)	(i) Cortex;	1
	(ii) X = Proximal convoluted tubule / distal convoluted tubule; Reject PCT Y = Bowmans capsule; Z = Glomerulus;	3
	(iii) Microvilli; Large numbers mitochondria; Folded basement membrane; Large number ribosomes;	3
(b)	arterial pressure high/ high blood pressure; Afferent vessel wider diameter than efferent; Increase in pressure in glomerulus; Pores between endothelial cells; Pores in basement membrane; Filtration slits podocyte feet; Eg. of a substance not filtered and one which passes through;	Max 4
Question 9 Total		[11]

10. (a) (i) glomerulus [1]
- (ii) urea, amino acids, fatty acids / glycerol / small proteins /
inorganic ions / salt (name two for 1 mark) [1]
- (iii) ultrafiltration [1]
- (iv) blood pressure decreased; less filtrate formed [2]
- (b) (i) microvilli provide a large surface area for absorption;
many mitochondria for active transport [2]
- (ii) loop of Henle [1]
- (c) (i) blood is taken from a vein;
dialysate passes in opposite direction in the machine;
dialysis fluid has the same water potential and concentration of
ions and glucose as blood of patient;
urea and excess water and salt diffuses;
from blood into dialysate because of the concentration gradient
from the blood into the dialysis fluid. (any four points) [4]
- (ii) glucose would diffuse out of the patient's blood and would lead
to a shortage of glucose. [1]
- (iii) cheaper in the long term /
frequent hospital visits or confined to machine for periods. [1]
- (iv) shortage of donors;
Organ rejection / immunosuppressant drugs
Matching tissue type / blood group [2]

[Total 16 marks]

11.

Question			Marking details	Marks Available					
				AO1	AO2	AO3	Total	Maths	Prac
11	(a)	(i)	Between glomerulus and Bowman's capsule	1			1		1
		ii	Correct answer = 30 000 = 2 marks $\frac{15\text{mm} \times 10^6}{500}$ (1) Evidence of Image/Actual		2		2	2	
	(b)	(i)	$8 - 4 - 2.6 = 1.4 \text{ kPa}$		1		1	1	
		(ii)	1. There is less protein in the {plasma/blood} (1) 2. So the osmotic pressure decreases/water potential higher/water potential less negative (1) 3. So overall pressure increases and {more filtrate is produced/rate is faster}(1)		3		3		
		(iii)	Dilate the afferent vessel/afferent vessel gets wider/ muscle (in walls) relaxes (1) Constrict the efferent vessel/efferent gets narrower/ muscles (in walls) contract (1)			2	2		
	(c)		They are too large to {diffuse back in/pass through/to be reabsorbed}(1) There are no {specific carriers/transport proteins/carrier proteins/channel proteins} for them (1)			2	2		
	(d)	(i)	(Only) water reabsorbed/water leaves tubule by osmosis/diffusion (1)		1		1		
		(ii)	point drawn at 40 au/100% (1) Line drawn with ruler between points (1) No extrapolation/sketchy line		2		2	2	
	(e)	(i)	{Provide/Release} energy/{produce/provide/release/synthesise} ATP (1) Reject produce/make energy For active {transport/uptake}/for pumping correct named molecule (1)	2			2		
		(ii)	{Give larger/increased/large} surface area <u>for absorption/or description of</u>	1			1		
	(f)		Any 4 × (1) from: 1. Ammonia is <u>more</u> toxic than urea (1) 2. so needs to be diluted/washed away constantly/more soluble than urea (1) 3. Mud: Need to conserve water(1) 4. Urea needs less water for excretion/if ammonia was used, a lot of water would be lost (1) 5. Urea can be stored (because it is less toxic) (1)		2	2	4		
			Question 11 total	4	11	6	21	5	0

12.	Question	Marking details	Marks Available max 4	Question	Marking details	Marks Available
12	(i)	Any 4 from Increased levels of urea in blood; Increased levels of {ions / named ion/ salt} in blood; Increased water levels in blood / swelling legs / shortness of breath; Increase in water potential of blood; Reduced volume of urine; Blood in urine; Nausea; Itching (caused by high levels phosphate); Bone damage/ slow bone healing; Muscle cramps/ abnormal heart rhythm/ muscle paralysis; Decreased numbers RBC / tiredness/ dizziness;		(iii)	High conc. calcium in blood - diffuses from blood to dialysate, Low conc. in blood - from dialysate to blood./ maintain constant level in blood;	1
				(d)	Any 2 from Risk to living person, surgery, one kidney only; Ethics of using kidney from cadaver; Ethics of removing kidney from brain dead person; Ethics of using fetal material; Increased risk of people selling kidneys; Ethics of giving transplant to elderly person; Rejection / infection/ surgical risks; Use of immunosuppressant's increase risk of infection / cancer;	max 2
	(ii)	Fall in blood pressure; Ultrafiltration no longer takes place;	2	(e)	Secretes hormones (erythropoietin/ calcitriol)into blood;	1
	(b)	High blood pressure; Ref. vein not having a thick muscular wall;	2	Question 12 total		[14]
	(c) (i)	Maintain {diffusion gradient/ concentration gradient}; Accept prevent urea diffusing back	1			
	(ii)	Countercurrent maximise concentration gradient along length of tube/ stop equilibrium; Accept blood and dialysis fluid do not reach same urea concentration	1			

13.

Question			Marking details	Marks Available
13	(a)		renal artery;	1
	(b)		many {pores/ gaps} in the {capillary wall/endothelium / fenestrated wall}; basement membrane with {pores / molecular sieve} (through which large molecules cannot pass); efferent arteriole has {smaller <u>diameter</u> / narrower <u>lumen</u> } than afferent;	2 max
	(c)		(all) glucose (selectively) reabsorbed; (reabsorption) in the proximal convoluted tubule; (reabsorption) by active transport;	2 max
	(d)	(i)	A. water {reabsorbed from filtrate/removed from filtrate}; B. less urea reabsorbed / urea not reabsorbed; C. {sodium / mineral ions} reabsorbed in proximal convoluted tubule; D. therefore water reabsorbed by osmosis in proximal convoluted tubule; E. {active transport/ pumping} of Na ⁺ ions in the ascending limb of the loop of Henle; F. water reabsorbed from filtrate in the descending limb of loop of Henle/ descending limb is permeable to water/ ascending limb impermeable; G. hypertonic conditions /high solute concentrations in the medulla/ lowering water potential of medulla/ correct description of concentration gradient towards apex of loop; H. therefore water reabsorbed in the collecting duct/distal convoluted tubule;	5 max
		(ii)	less water lost (in urine)/ conserves water; reduces risk of dehydration; useful in dry habitats/ adaptation to terrestrial life;	2 max
	(e)		ADH /anti diuretic hormone; {increases reabsorption of water/ increases permeability of collecting duct to water / opens more aquaporins} <u>so increases ion concentration</u> ;	2
Question 13 Total				[14]

14.

Question			Marking details	Marks Available
14	(a)	(i)	A = collecting duct; B = efferent arteriole; C = glomerulus; D = afferent arteriole; E = Bowman's/renal capsule; F = loop of Henlé; (one mark for every two correct)	3
		(ii)	line to proximal convoluted tubule;	1
		(iii)	line to proximal convoluted tubule;	1
		(iv)	causes increase in blood pressure; forces components of plasma into Bowman's capsule; ultrafiltration;	2
	(b)	(i)	same concentration of both in plasma and filtrate; forced from plasma/ glomerulus into capsule; small molecules; so can pass through gaps;	3 max
		(ii)	concentration of urea increases in tubule; so water is reabsorbed; figs to support (1.0 – 1.7); into capillaries; urea not reabsorbed;	4 max
		(iii)	glucose normally reabsorbed in proximal convoluted tubule; ratio falls from 1.0 to 0.0 in untreated kidney; prevented by chemical Z; ratio in untreated kidney therefore rises from 1.0 to 1.4; because of water reabsorption;	3 max
		(iv)	inhibits active transport/ blocks protein pores; Respiratory inhibitor/ less ATP/Affects co transport;	1 max
	Question 14 Total			[18]

15.

Question	Marking details	Marks Available
15 (a)	Removal of waste;	1
(b) (i)	68;	1
(ii) I	The salts enter urine/ excreted/ some are reabsorbed;	1
II	Concentration increases;	2
	Because water intake lower and percentage of intake that passes into urine is lower'/ because the volume of urine is lower;	
(iii)	Restore (normal) levels/ return to normal/ replenish salts;	1
Question 15 Total		[6]

16.	Question	Marking details	Marks Available
16		Indicative content The brain monitors whether there is too much water in the blood, and so little ADH is released. Dilute urine is excreted because the kidney tubules do not absorb much water to pass it back to the blood. If there is too little water in the blood, then more ADH is released causing concentrated urine to be excreted because the kidney tubules absorb a lot of water and pass it into the blood. 5-6 marks The candidate constructs an articulate, integrated account correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar. 3-4 marks The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar. 1-2 marks The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar. 0 marks The candidate does not make any attempt or give a relevant answer worthy of credit	6
Question 16 Total			[6]

17.	Question			Marking details	Marks Available				
					A01	A02	A03	Total	Maths Prac
17				Indicative content Ecstasy - ADH increases permeability of {DCT /collecting duct} to water - more aquaporins added into the cell membrane - more water reabsorbed (and lower volume of urine produced) - increases sweat production so reduces {urine volume/ water potential of plasma} Furosemide - ions transported out of ascending limb of Loop of Henle into tissue fluid of medulla - lower solute/water potential of tissue fluid/ creates a water potential gradient in medulla - Water moves out of {descending limb/ collecting duct} by osmosis - this reduces volume of {filtrate/ urine} - fewer ions into medulla reduces water potential gradient so less water reabsorbed from {descending limb/collecting duct} {filtrate /urine} volume remain high Hyponatraemia - ecstasy causes increased body temperature – body reacts by sweating resulting in increased loss of Na⁺	3	3	3	9	

			- ecstasy causes increased thirst – blood is diluted - ecstasy too much water reabsorbed dilutes the blood (furosemide inhibits transport of Na^+ out of filtrate) so more Na^+ are passed out in urine - furosemide also increases urine volume so more Na^+ lost from body						
			7-9 marks A clear account of the role of the loop of Henle and ADH/collecting duct interaction is given. This is related in detail to the action of MDMA in increasing permeability of the collecting duct to water through the incorporation of more aquaporins and also how furosemide decreases the reabsorption of water by decreasing the water potential gradient between the filtrate and the tissue fluid in the medulla. A detailed explanation is given of how both drugs can lead to low blood Na^+ levels. <i>The candidate constructs an articulate, integrated account, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses scientific conventions and vocabulary appropriately and accurately.</i> 4-6 marks The involvement of the loop of Henle and the collecting duct, together with the role of ADH is described. The effects of MDMA and/or furosemide are linked to these structures and their effect on the volume of urine is explained. A sound attempt is made to explain how both drugs can result in hyponatraemia. <i>The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate usually uses scientific conventions and vocabulary appropriately and accurately.</i>						
			1-3 marks The formation of urine is described and an attempt is made to relate the action of MDMA or furosemide to the changes in urine volume. A basic attempt is made to explain how one of these drugs can result in hyponatraemia. <i>The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate has limited use of scientific conventions and vocabulary.</i>						
			Question 17 Total	3	3	3	9		