Mark scheme

Question			Answer/Indicative content	Marks	Guidance
1	a	i	Any **one** (named) banned substance from: e.g. rhEPO **OR** (named) anabolic / androgenic , steroid e.g. nandrolone **OR** (named) narcotic drug e.g. cannabis / methadone **OR** (named) stimulant e.g. amphetamine **OR** e.g. (named) peptide / steroid , hormone e.g. testosterone ✓	1	**ALLOW** either banned substance or a named substance − check with IOC list **IGNORE** (named) diuretics / alcohol **Examiner's Comments** Most candidates were able to name a banned substance and examiners were given a wide range of drugs suggested by candidates that are currently on the IOC list. The most common correct response was anabolic steroid, alternatives included a named steroid hormone e.g. testosterone or named illegal drugs e.g. amphetamines. Some candidates referred to steroids without further qualification which was not awarded.
		ii	*idea that* collecting duct becomes less permeable to water ✓ (rapid) water loss ✓ larger volume of urine produced ✓	max 2	**ALLOW** e.g. fewer aquaporins inserted into collecting duct wall **ALLOW** reduction in 'water weight' **ALLOW** more water lost in urine **ALLOW** more / greater amount of urine produced **Examiner's Comments** Most candidates gained at least one mark for this question with credit given for stating that more water would be lost, often expressing this as a loss of 'water weight'. Many candidates then went on to restate the information in the question stem without giving detail of the action of the diuretic leading to the decrease in reabsorption of water in the collecting ducts. Good responses linked the change in reabsorption of water to the drug causing reduction in permeability of collecting duct walls and some went on to include detail of how this happens via aquaporins.

		iii	it could increase removal of , (performance enhancing) drugs / other banned substances **OR** (performance enhancing) drugs / other banned substances , are undetectable in larger volume of urine produced ✓	1	**ALLOW** e.g. it could increase removal of ***them*** as drugs is mentioned in question stem **ALLOW** AW e.g. the concentration of drug would be too small to be noticed **ALLOW** more dilute for larger volume of urine **Examiner's Comments** Good responses were seen where candidates used the information provided and applied it to make a valid suggestion. Responses gaining credit commonly expressed the idea that the larger volume of urine or more dilute urine would lead to the drug being at such low concentration as to be undetectable.
	b	i	it does not require surgery / no recovery time required ✓ less painful / less chance of infection (after surgery) ✓ it is more rapid / gives results more quickly ✓ it is , less expensive / cheaper ✓	max 1	**IGNORE** disadvantages of biopsy **ALLOW** is , not / less , invasive **ALLOW** less damage to (named) tissues **Examiner's Comments** Generally well-answered by most candidates.
		ii	any **one** from (needs substance and application): glucose **AND** diabetes **OR** protein **AND** kidney disease / albuminuria **OR** creatinine **AND** kidney disease / muscle damage ✓	max 1	**ALLOW** other correct substance and condition e.g. hCG **AND** pregnancy **ALLOW** kidney failure / kidney damage for kidney disease **Examiner's Comments** Most candidates were able to state a substance and relevant medical condition. The most common correct responses were glucose **and** diabetes or hCG **and** pregnancy.
	c		**Level 3 (5−6 marks)** Describes in detail the regulation of the water content of blood with reference to action of ADH **AND** role of receptors **AND** (posterior) pituitary *There is a well-developed line of*	6	**Loss of mark for communication statement if incorrect science / terminology used** **e.g anterior pituitary rather than (posterior) pituitary / ADH secreted by adrenal gland** **OR give details of setting up a**

			reasoning which is clear and logically structured. The information presented is relevant and substantiated. **Level 2 (3−4 marks)** Describes the regulation of the water content of blood with reference to action of ADH **AND** receptors **OR** Describes the regulation of the water content of blood with reference to receptors **AND** (posterior) pituitary **OR** Describes the regulation of the water content of blood with reference to action of ADH **AND** (posterior) pituitary *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.* **Level 1 (1−2 marks)** Describes the regulation of water content of blood with reference to the action of ADH **OR** receptors **OR** (posterior) pituitary *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.* **0 mark** *No response or no response worthy of credit.*		**water potential gradient** **OR** **if no ref to homeostatic mechanism e.g. returning water potential of blood to normal value / ref to negative feedback** **Indicative scientific points may include:** ***Mechanism of ADH action*** • ADH targets / binds to cells of collecting duct • release of second messenger • vesicles with aquaporins fuse with plasma membrane • increase in permeability of collecting duct wall • more water moves down water potential gradient into cells ***Role of Receptors*** *Sensory receptors* • sensory receptors located in the hypothalamus • osmoreceptors • detect changes in osmotic pressure / water potential of blood • respond to effects of osmosis by shrinking or swelling *Receptors in collecting duct* • receptors located on cells of collecting duct ***(Posterior) pituitary*** • ADH made in hypothalamus • moves down axon to posterior pituitary • stored in vesicles • action potentials in neurosecretory cells • ADH released by posterior pituitary • by exocytosis • from neurosecretory cells

					Examiner's Comments There were some excellent Level 3 responses to this Level of Response question showing that many candidates had a good knowledge and understanding of the homeostatic mechanisms involved and could describe osmoregulation in detail. Responses given Level 2 most commonly did not mention the role of the (posterior) pituitary gland or gave incorrect accounts of ADH production and release. Other indicative points e.g. movement down axon to posterior pituitary, being stored in vesicles, action potentials causing release from neurosecretory cells by exocytosis, were very rarely seen. Lower level responses were seen where candidates included vague ideas of ADH acting on the collecting ducts but no relevant detail and so there were omissions or errors in their accounts. Exemplar 2  If there is low water potential in the blood it is detected by the osmoreceptors in the hypothalamus. This then causes the secretion of ADH released from the pituitary gland and it travels in the blood to the collecting duct. The ADH binds to the receptors on the collecting duct which release vesicles of aquaporins making the duct more permeable. So more water is reabsorbed at the capillaries. If the water potential in the blood is high then the osmoreceptors detect it and stop the release of ADH to ~~also~~ mean less water is reabsorbed ~~and~~ so it leaves in the urine. This is an example of negative feedback as the body is responding to oppose the change it has detected This Level 3 response makes reference to the role of receptors, both osmoreceptors in the hypothalamus and receptors on the walls of collecting ducts in the nephron. They state that ADH is released from the pituitary gland and describe the action of ADH clearly, including a description of vesicles of aquaporins. There are no science errors, and they refer to negative feedback in their response.
			Total	**12**	

2			*Patient **A*** 1 increase in eGFR which is in line with that expected during pregnancy / AW ✓ 2 (high eGFR) explains increase in (urine concentration of) , glucose / protein ✓ *Patient **B*** 3 has <u>much</u> lower eGFR than a healthy person ✓ 4 less / no , ultrafiltration so level of (named) electrolytes is high(er) than healthy person ✓ 5 very high protein (concentration) in urine indicates damage to , nephron / glomerulus / Bowman's capsule ✓ 6 correct calculation to support statement for **either** patient **A** or patient **B** ✓	max 4 (AO3.2) (AO2.2)	**MP1 ALLOW** patient **A** has eGFR about 50% higher than normal which is consistent with pregnancy **MP3 ALLOW** patient B has very low eGFR compared to normal / 107cm^3 min^{-1} **MP4 IGNORE** ref. to reabsorption **MP5 ALLOW** ...in basement membrane / renal corpuscle **MP6** is awarded **once** only for patient **A** or **B** **e.g.** Patient **A** has 51.4% / 51% increase in eGFR **e.g.** Patient **A** 50% is 161 and 85% is 198 so eGFR within range **e.g.** Patient **B** eGFR has decreased by 67.3% / 67% **<u>Examiner's Comments</u>** This question proved challenging for candidates. Good responses noted the increased eGFR for patient A was within the pregnancy range stated, and also included a calculation to demonstrate this point. Some candidates misunderstood the information in the question stem and said the doctor was correct in diagnosing that patient A was pregnant. Some candidates compared the eGFR of patient B with patient A rather than to a person with a normal eGFR. Vague responses describing that patient B's very high protein measurement was linked to kidney failure, rather than explaining the exact possible cause, e.g. damage to the Bowman's capsule or basement membrane did not gain credit. Some candidates who commented on the high electrolytes in patient B thought it was due to a lack of reabsorption, indicating that candidates did not fully understand that eGFR is linked to the ultrafiltration process at the glomerulus rather than other parts of

					the nephron. Very few candidates successfully linked patient A's increased glucose or protein levels to the higher eGFR. Some candidates did mention the elevated levels but linked those to complications with the pregnancy itself such as, gestational diabetes.
			Total	**4**	
3	a	i	T = (renal) medulla ✓ U = (renal) cortex ✓ V = pelvis ✓	3 (AO2.3)	**ALLOW** (renal) pyramid **Examiner's Comments** This question required straightforward recall of kidney structure. Most candidates correctly identified medulla and cortex for T and U, although some candidates gave these the wrong way round. A common error was referring to 'adrenal medulla' or 'adrenal cortex' which was not credited. Ureter or renal artery was the most common incorrect response for V.
		ii	U ✓ (shows) glomerulus / Bowman's capsule ✓	2 (AO2.3)	**ALLOW** cortex **Examiner's Comments** Most candidates correctly identified the region shown in the photomicrograph of the kidney and were able to give a correct explanation of the features which identified it.
	b	i	Z ✓ W ✓ Y ✓	3 (AO2.1)	**IGNORE** Y **Examiner's Comments** Generally, this question was well answered. Most candidates correctly identified region Z as being the site of action for ADH and W for the region with the most hydrostatic pressure. The most common incorrect response was in the third row, where candidates stated X, or X and Y, suggesting confusion between the roles of the proximal and distal convoluted tubules.
		ii		max 3 (AO1.2)	**MP2** to **MP4 ALLOW** sodium / Na / chloride / Cl , ions **MPs 2** to **4** if only 'ions' used or

			1 ascending limb is impermeable to water / water cannot leave the ascending limb ✓ 2 Na^+ / Cl^-, diffuse , out of lower part of ascending limb ✓ 3 active transport of , Na^+ / Cl^-, out of (upper part of) ascending limb ✓ 4 diffusion of , Na^+ / Cl^-, into descending limb ✓ 5 water leaves the descending limb by osmosis ✓ 6 ref to countercurrent multiplier ✓		incorrect ions e.g. K+ apply ECF once only **MP2** and **MP4 ALLOW** down concentration gradient for diffusion **MP3 ALLOW** pumped for active transport **MP5 ALLOW** down water potential gradient for osmosis **Examiner's Comments** Good responses gave clear descriptions of the movement of named ions and water, correctly identifying which part of the loop was involved and were specific about the roles of the descending and ascending limb. Some candidates were unable to name the ions or did not identify the mechanism by which the ions or water were moving. Common errors included listing the wrong ions, such as K^+ or Ca^{2+}, or not mentioning which limb was being described. Weak responses stated that the loop of Henle decreased the water potential in the medulla but could not explain in detail how this was achieved. Others also often referred to solutes or salt rather than named ions.
			Total	**11**	