

Mark schemes

(a) Hypothalamus.

1 **1**

(b) 1. Water potential of blood will decrease;
2. Water moves from osmoreceptor into blood by osmosis. **2**

(c) 1. Permeability of membrane / cells (to water) is increased;
2. More water absorbed from / leaves distal tubule / collecting duct;
3. Smaller volume of urine;
4. Urine becomes more concentrated. **4**

(d) 115.2 / 115.3 (cm³ minute⁻¹). **1**

(e) Any **two** of the following for 1 mark:
Muscle / body mass
Ethnicity
Exercise
Kidney disease – do not accept 'health'. **1**

[9]

1 (a) Hydrostatic pressure / description of pressure / description of how pressure generated;

2

Causes ultrafiltration (*Allow description of ultrafiltration*) at Bowman's capsule / glomeruli / renal capsule;
Through basement membrane;
Enabled by small size urea molecule;

2 **max**

(b) Reabsorption of water / by osmosis;
At the PCT / descending LoH;
At the DCT / CD;
Active transport of ions / glucose creates gradient (in context);
Ignore references to facilitated diffusion or to selective reabsorption.

3 max

[5] (a) 1. Blood pressure / hydrostatic pressure;

3

2. Small molecules / named example;
3. Pass through basement membrane / basement membrane acts as filter;
4. Protein too large to go through / large so stays behind;
5. Presence of pores in capillaries / presence of podocytes;

5

- (b)
1. High concentration of glucose in blood;
 2. High concentration in tubule / in filtrate;
 3. Reabsorbed by facilitated diffusion / active transport;
 4. Requires proteins / carriers;
 5. These are working at maximum rate / are saturated;
 6. Not all glucose is reabsorbed / some is lost in urine;

4 max

(c) For general principle, applied to either example:

1. More water (from filtrate) reabsorbed / returned to blood / less lost in urine;
2. By osmosis;
3. From collecting duct / from end of second convoluted tubule;
4. Due to longer loop of Henle;

For loop of Henle, maximum 2 marks:

5. Sodium / chloride ions absorbed from filtrate in ascending limb;
6. Gradient established in medulla / concentration of ions increases down medulla;For

ADH, maximum 2 marks:

7. Acts on collecting duct / distal convoluted tubule / second convoluted tubule;
8. Makes cells more permeable / inserts aquaporins in plasma membranes;

Note: to score full marks, candidates must make one specific statement about Loop of Henle and one about ADH.

6 max [15]

(a) In Diabetic person:

4

1. Lack of insulin / reduced sensitivity of cells to insulin;
2. Reduced uptake of glucose by cells / liver / muscles;
3. Reduced conversion of glucose to glycogen;

*Penalise zero / no
once only*

3

(b) (i) Leaves the blood at kidney;
Taken back into blood / reabsorbed (from kidney tubule);

Reject some reabsorption

(Reabsorbed) in 1st convoluted tubule;

Kidney / named part needs to be mentioned once

2 max

(ii) Large amount / high concentration of glucose in filtrate;
Cannot all be reabsorbed / 1st convoluted tube too short to reabsorb
all of glucose / saturation of carriers;

2

(c) Enzyme has specific shape to active site / active site has specific tertiary structure;
Only glucose fits / has complementary structure / can form ES complex;

2

(d) Glucose in filtrate lowers water potential;
Ignore 'urine'. Accept increase solute potential

Lower Ψ gradient / less difference in Ψ filtrate – Ψ plasma;
Ignore 'concentration'

Less water reabsorbed by osmosis;
Accept diffusion of water. Reject no water reabsorbed if implied

3

(e) 1. Glomerulus / Bowman's capsule / renal capsule;
2. Basement membrane;
3. Proteins are large (molecules) / proteins cannot normally pass through filter / proteins can only pass through if filter damaged;

3 [15]

metabolic water / from respiration;

5

allow condensation reactions. Ignore 'oxidation'.

aerobic / use of oxygen; ('From aerobic respiration' = 2 marks)

[2] (a) (i) where a change triggers a response which reduces the effect of a change;

6

1

(ii) e.g. sweating, breathing, defaecating, other valid example;
(reject respiration evaporation not acceptable as a 2nd mark if sweating or breathing given)

2 max

(iii) hypothalamus;

1

(b) (i) pituitary;
(ignore anterior pituitary)

1

(ii) 1. ADH causes vesicles containing aquaporins / aquaporins to be inserted into membrane / collecting duct wall / plasma;
2. water enters cell through aquaporins;
3. by osmosis / diffusion / down a water potential gradient;
4. (from cell) to capillary;
5. via interstitial fluid;

4 max

(c) (i) excessive urination / drinking / diluted urine / thirst;

1

(ii) because males only have one X chromosome / do not have Y chromosome; a single copy of the recessive allele will be expressed;

2

(iii) recessive alleles can be carried by individuals without showing effects / dominant allele always expressed; organism that are carriers more likely to reproduce / affected organism less likely to reproduce; therefore recessive alleles are more likely to be passed on / dominant alleles less likely to be passed on;

3

[15]

(a) Lower volume AND higher concentration;

7

ADH
increases
water
re-
absorption
(in 2nd
convoluted
tubule
/
collecting
duct) /
increases
water
permeability
/ adds
aquaporins;

Evidence: observe increasing concentration (of dissolved substances) (in 2nd convoluted tubule / collecting duct) / concentration increased c.f. ADH absent
Once only for full marks

3

(b) Protein molecule too large (to cross filter in healthy person);

Protein can cross if filter is damaged / protein from damaged glomerulus enters filtrate;

2

[5] (a) any two named polymers [subsets = 1 max. (e.g. protein / haemoglobin)]

8

2

(b) (i) hydrostatic pressure / description of pressure; causes ultrafiltration at Bowman's capsule / glomeruli / renal capsule; through basement membrane; enabled by small size of urea molecule;

max 2

(ii) reabsorption of water; [water out] by osmosis; at the PCT / descending LoH; at the DCT / CD; active transport of ions / glucose creates gradient (in context);

max 4

(c) (i) by (simple) diffusion;
[reject facilitated]

1

(ii) to maintain concentration gradients / stop reaching equilibrium;
[idea of maintaining concentration gradients]

1

(iii) ions, glucose and amino acids would diffuse into the dialysate; because of their concentration gradients; Causing deficiency in these substances;

OR

the WP of the dialysate would be higher / less negative than the WP of the surrounding tissues; therefore osmosis would take place into the cells surrounding the abdominal cavity; causing these cells to burst / damaging these cells / cannot be excreted;

max 2

[12] (a) Pituitary;

9

Ignore any reference to lobe / hypothalamus.

1

(b) (i) (Each) protein has a tertiary structure;
Gives specific / correct shape / size to (inside of) channel / pore;

2

(ii) More negative / lower WP (inside tubule cells);
accept Ψ symbol / down a WP gradient

Water enters / moves by diffusion / osmosis;
ignore water concentration, etc.

2

10*Accept vasopressin*

- 1
- (b) Reabsorption / passes back into blood / tissue fluid;
- 1
- By active transport;
- 1
- (c) (sodium) ions pumped out of ascending limb;
- 1
- Water passes out of descending limb (into high concentration in tissue fluid / interstitial fluid);
- 1
- Some sodium ions re-enter descending loop (by diffusion);
- 1
- High concentration at base of loop / some ions diffuse out near base increasing concentration outside loop;
- 3 max*
- 1

[6]

- (a) Maintaining a constant internal environment;

11 1

- (b) Binds to (specific) receptor;
On muscle / liver cell;
Activation of enzymes (in liver);
Hydrolysis of glycogen;
(Facilitated) diffusion of glucose out of (liver cells) cells;
Increases blood glucose levels;
- 4
- (c) (i) 0 / zero;
- 1
- (ii) 1. Filtration, out of blood (plasma) / into renal capsule;
2. (Hydrostatic) pressure ;
3. PCT;
4. All reabsorbed;
5. Active transport;

3 max

- [9] (a) (i) Renal capsule / Bowman's capsule / glomerulus / basement membrane;

(ii) blood cells / platelets / proteins / named plasma protein;

1

(b) 75 divided by 60 / 75 divided by 0.01;

1

Answer 125;

(Correct answer gains two marks)

1

(c) (Many) mitochondria provide ATP / energy for active transport;
 (Many) carrier proteins for active transport / channel proteins for facilitated diffusion;
 Microvilli / brush border provide large surface area (for absorption);

2 max

[6] (a) (i) 1. In the ascending limb sodium(ions) actively removed;

2. Ascending limb impermeable to water;
 3. In descending limb sodium(ions) diffuse in;
 4. Descending limb water moves out / permeable to water;
 5. Low water potential / high concentration of ions in the medulla / tissuefluid;
 6. The longer the loop / the deeper into medulla, the lower the waterpotential in medulla / tissue fluid;
 7. Water leaves collecting duct / DCT;
 8. By osmosis / down water potential gradient;
- (credit once only)*

6 max

- (ii) 1. When water potential of the blood too low;
2. Detected by receptors in the hypothalamus;
 3. Pituitary secretes / releases (more) ADH;
 4. ADH increases the permeability / recruitment of aquaporins / openschannels for water in the DCT / collecting duct;
 5. More water is reabsorbed / leaves the nephron moves into the blood;
 6. By osmosis down the water potential gradient;

4 max

(b) (i) Ammonia not urea;
 Ammonia (into labyrinth) enters by diffusion, not (ultra) filtration;
 Reabsorption of glucose from labyrinth, not PCT / no reabsorption in PCT;
 All salt reabsorbed / no salt in urine, comparison to humans;
 Concentrated urine not produced;

3 max

(ii) Water potential lower in cytoplasm of cells / fresh water higher water potential than cells / idea of water potential gradient;
 (Removal of excess water) prevents osmotic damage;

OR

All salts reabsorbed (because difficult to replace);
Take in excess water and need to remove it;

2

[15] (a) e.g. urea / amino acids / fatty acids / glycerol / ion / small protein;

14

(one mark for two of above)

1

(b) blood pressure decreased;
(less pressure) forms less filtrate;

2

(c) microvilli provide large surface area; carrier proteins (in membrane) for active transport; channel proteins for facilitated diffusion; specific carriers for specific molecules / sodium pumps;
(many) mitochondria for active transport;

2 max

(d) (i) up to 2.2 mg cm^{-3} all glucose reabsorbed / above 2.2 mg cm^{-3} excess glucose not reabsorbed / at 2.2 mg cm^{-3} threshold value reached; saturation of carriers / active transport mechanism;

2

(ii) decrease in insulin production / receptors not responsive to insulin / specific damage to tubule described / membrane less permeable to glucose;

1

[8]

(a) ADH;

16

(accept vasopressin)

1

(b) reabsorption / passes back into blood; by active transport;

2

(c) (sodium) ions pumped out of ascending limb; water passes out of descending limb (into high concentration in tissue fluid / interstitial fluid);
some sodium ions re-enter descending loop (by diffusion); high concentration at base of loop / some ions diffuse out near base increasing concentration outside loop;

3 max

[6] (a) (epithelial cell) of tubule cells carry out active transport;

17

transport chloride / sodium ions out (of filtrate); against concentration gradient; into surrounding tissue / tissue fluid;
creates / maintains water potential gradient for water reabsorption; countercurrent multiplier;

5 max

- (b) if water potential of blood falls, detected by receptors in hypothalamus; leads to ADH released from pituitary gland; ADH makes cells of collecting duct / distal convoluted tubule permeable to water;
(accept DCT)

water leaves filtrate by osmosis;
smaller volume of urine produced;

(accept converse if water potential of blood rises)

4 max

- (c) (autonomic reflex), autonomic ganglion involved; extra synapse outside the spinal cord; inhibitory rather than excitatory neurone; more neurones involved;

2 max

[11]

- 18** (a) (i) (Kidneys) *function*: removes urea from blood, *evidence from graph*: when kidneys not working the level of (blood) urea rises;

1

- (ii) (Liver) *function*: makes urea / adds urea to blood, *evidence from graph*: no rise in urea (when liver not working) OR when working, urea not removed, so level rises;

1

- (b) *Shown on graph. Firstly need to demonstrate change in gradient at 12 hours. Time 0 to 12 hours – steady decline in urea level (below line Q); Curve horizontal from 12 hours; Still award full credit if the line falls to x axis within first 12 hours and remains on the x axis thereafter.*

2

[4]