



# **A-Level Biology**

## **Osmoregulation**

### **Mark Scheme**

**Time available: 80 minutes**

**Marks available: 63 marks**

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## Mark schemes

1.

(a)

*Ignore references to podocytes*

1. High blood/hydrostatic pressure;  
*Ignore references to afferent and efferent arterioles*  
*Ignore 'increasing/high er blood pressure' as does not necessarily mean high*
2. **Two named** small substances pass out eg water, glucose, ions, urea;  
*Accept correct named ions*  
*Accept mineral ions/minerals*  
*Accept amino acids/small proteins*  
*Ignore references to molecules **not** filtered*
3. (Through small) gaps/pores/fenestrations in (capillary) endothelium;  
*Accept epithelium for endothelium*
4. (And) through (capillary) basement membrane;

3 max

- (b)  Glucose by facilitated diffusion and active transport and water down a water potential gradient

1

- (c) 17.4;

*Accept any number of fours after the decimal point.*

1

- (d) 1. Thicker medulla means a longer loop (of Henle);
2. (The longer the loop of Henle means) **increase** in sodium ion concentration (in medulla)
- OR**
- (The longer the loop of Henle means) sodium ion gradient maintained for **longer** (in medulla)
- OR**
- (The longer the loop of Henle means) **more** sodium ions are moved out (into medulla);

*Must have idea of increase/longer/more*

3. (Therefore) water potential gradient maintained (for longer), **so** more water (re)absorbed (from loop and collecting duct);

**OR**

More water is (re)absorbed **from** the loop (of Henle) / collecting duct **by** osmosis;

*Reject water being reabsorbed **into** the loop of Henle*

*Direction is important*

*Accept  $\Psi$  for water potential*

3

**[8]**

**2.**

- (a) Water is also reabsorbed

1

- (b) 1. Concentration rises in descending limb because sodium ions enter and water lost;
2. Concentration falls in ascending limb because sodium ions (and chloride) ions actively removed;
3. But water remains (in ascending limb) because its walls are impermeable (to water).

3

- (c) 1. Concentration rises in collecting duct because it loses water by osmosis;
2. ADH increases permeability (of walls of collecting duct) to water.

2

**[6]**

**3.**

- (a) Hypothalamus.

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 (cm<sup>3</sup> minute<sup>-1</sup>).

1

(e) Any **two** of the following for 1 mark:

Muscle / body mass

Ethnicity

Exercise

Kidney disease – do not accept 'health'.

1

[9]

4.

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

5.

(a) 1. Blood pressure / hydrostatic pressure;

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]

6.

(a) In Diabetic person:

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 1<sup>st</sup> 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 / 1<sup>st</sup> 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  $\Psi$  gradient / less difference in  $\Psi$  filtrate –  $\Psi$  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]

7.

- (a) Lower volume AND higher concentration;  
ADH increases water re-absorption (in 2<sup>nd</sup> convoluted tubule / collecting duct) /  
increases water permeability / adds aqua porous;

Evidence: observe increasing concentration (of dissolved substances) (in 2<sup>nd</sup>  
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]