AQA A-LEVEL · 7402

BIOLOGY



MARK SCHEME

3.6.4.3 OSMOREGULATION

SCORE	PERCENTAGE
/163	%

STEMUP

These questions belong to AQA, not to us.

The examination questions, mark schemes and examiner reports in this pack were written and published by AQA. They are past assessment materials, reproduced here so that students can revise from them.

What we do not own

STEMUP is not affiliated with AQA and does not own, and makes no claim to own, any of the question, mark scheme or examiner report material in this pack. AQA has not endorsed, approved or been involved in the production of it. AQA and the qualification titles used here belong to their respective owners and appear for identification only.

Where to find the originals

AQA publishes its past papers, mark schemes and examiner reports free of charge. Always check the current specification at aqa.org.uk before you revise, because content and wording can change between series.

If you hold the rights to any material in this pack and would like it amended or removed, contact admin@stemup.co.uk and we will act on it.

Q1.

(a) 1. Affects water potential (of blood/body);
Accept Ψ for water potential

2. Affects <u>volume</u> of urine (produced/removed);

2

(b) 1. Furosemide **and** CVT more effective than placebo/control/C
OR
Furosemide more effective (than CVT);
Accept both (drugs)/A and B more effective than placebo/control/C

2. Correct reference to a significant increase/difference as SD's do not overlap;

2

(c) Lower <u>volume</u> of blood;

1

(d) 1. Water potential of filtrate/tubule decreased;
Accept correct reference to water potential gradient
Accept maintains low water potential.
Accept nephron for filtrate/tubule.

2. Less water (reabsorbed) by <u>osmosis</u> (from filtrate/tubule);
Accept nephron for filtrate/tubule.
Accept no water (reabsorbed) for 'less'
Accept (more) water (absorbed) by <u>osmosis</u> (into filtrate/tubule)

3. Collecting duct (is where osmosis occurs);
Accept proximal convoluted tubule or distal convoluted tubule or (descending) loop of Henle
Ignore PCT, DCT.

3

(e) Accept answers in the range 33840 to 34680;

1

[9]

Q2.

(a) Water is also reabsorbed

1

(b) 1. Concentration rises in descending limb because sodium ions enter <u>and</u> 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]

Q3.

(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^3 $minute^{-1}$).

1

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

1

[9]

Q4.

(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]

Q5.

(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]

Q6.

(a) <u>In Diabetic person:</u>

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

Penalise zero / no
<u>once</u> only

3

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

Reject some reabsorption

(Reabsorbed) in <u>1st convoluted tubule</u>;

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]

Q7.

metabolic water / from respiration;
allow condensation reactions. Ignore 'oxidation'.

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

[2]

Q8.

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

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 <u>water potential</u> 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 <u>more likely</u> to reproduce / affected organism <u>less likely</u> to reproduce;
therefore recessive alleles are <u>more likely</u> to be passed on / dominant alleles <u>less likely</u> to be passed on;

3

[15]

Q9.

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

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]

Q10.

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

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]

Q11.

(a) Pituitary;
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

[5]

Q12.

(a) ADH;
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]

Q13.

(a) (i) Renal capsule / Bowman's capsule / glomerulus / basement membrane;

1

(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]

Q14.

(a) Maintaining a constant internal environment;

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]

Q15.

(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 / tissue fluid;
6. The longer the loop / the deeper into medulla, the lower the water potential 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 / opens channels 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]

Q16.

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

(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]

Q17.

(a) ADH;

(accept vasopressin)

1

(b) reabsorption / passes back into blood;
by <u>active</u> 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]

Q18.

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

Q19.

(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]

Q1.

(a) Approximately 50% of students scored zero for this question. Many of these responses related to “making the investigation a fair test”, to “controlling variables” or “to allow a comparison of the results”. The variation in water, salt and glucose content of different foods was mentioned by many students, but only the best answers stated that this would affect the water potential of the blood/body. Consequently, only 7% of students gained both marks. The idea that the volume of urine could be affected by consuming different foods was a more accessible marking point but the use of poor terminology, such as ‘amount of urine’, meant that students failed to gain a mark. There were several references to ‘volume of urine’ in the stem of the question to guide students to the use of correct terminology.

(b) The vast majority of students (94%) obtained at least one mark for this question. Most correct responses referred to furosemide being the most effective drug. Many also provided the alternative response for the same marking point, i.e. that both drugs were more effective than the placebo. Far fewer students referred to standard deviations, leading to approximately only 35% of students gaining a second mark. Even when students mentioned SDs overlapping they often did not refer to significance. The converse was also evident. Some students compared the spread of SDs and related this to the reliability of the results. Occasionally, ranges were mentioned rather than SDs.

(c) Less than a third of students obtained this mark. Although many students appreciated that furosemide removed excess fluid from the body by removing it in the urine, they did not all mention the reduction in the volume of blood. Again, poor use of scientific terminology was evident. A minority of students answered this in terms of baroreceptors and heart rate.

(d) Although approximately 27% of students scored zero, this question proved to be a good discriminator, with almost 50% of students obtaining at least two of the three marks available. There were some detailed, concise responses which showed an excellent understanding of the effect of furosemide on nephrons. Many students appreciated that an increase in concentration of sodium and chloride ions in the filtrate would decrease its water potential. This marking point was often credited for the converse idea, i.e. that the water potential would be higher in the blood/medulla. Similarly, many students were credited for stating that more water would be absorbed by osmosis into the filtrate, i.e. the converse of less water being removed. However, a significant minority of students referred to the osmotic movement of fluid rather than water, or incorrectly suggested that more water was reabsorbed from the collecting duct. Many students could name a part of the nephron where osmosis occurs, although a minority did refer to water movement between the medulla and the ascending loop of Henle.

(e) Surprisingly, only 20% of students obtained this mark. A common error was not to factor in that the mean rate of flow of blood plasma is 60% of the mean rate of blood flow into the kidneys. A common incorrect answer was 20400 cm^3.

Q6.

(a) Most candidates knew that diabetics were either deficient in insulin or had cells that were less responsive to insulin. Common misconceptions were that a diabetic was incapable of taking any glucose into the body cells, or that no glycogen could be made.

(b) Far too many candidates felt the need to reintroduce the effects of insulin in part (i), for example, by insisting that the non-diabetic person had no glucose in the blood entering the kidney and hence none would appear in the urine. Many candidates did, however, realise that the absence of glucose in the urine was due to its complete reabsorption in the first convoluted tubule. In part (ii), many candidates were confused about the mechanism of glucose reabsorption in the kidney and attributed it solely to diffusion. A considerable number of candidates also failed to make it clear precisely where the 'high concentration of glucose' to which they referred was located.

(c) It was pleasing that nearly all candidates were familiar with the concept that an enzyme has a precise shape to its active site and hence, in the case of glucose oxidase, only glucose would have a complementary shape and so be able to fit into it, forming an enzyme-substrate complex. Some candidates were careless and omitted details, such as 'active site' or 'shape'.

(d) In this section, there was some confusion about what constituted a high or a low water potential, although the vast majority did appear to understand this. Better candidates appreciated that the presence of glucose in the filtrate would lower its water potential, hence reducing the water potential gradient between the filtrate and the blood and, thus, reducing the amount of water that could be absorbed from the filtrate by osmosis. Inevitably, there was much omission of detail, but a major misconception was that water would move from the blood into the filtrate rather than that less than normal would move in the opposite direction.

(e) Nearly all candidates knew that proteins are large molecules and, thus, should not be able to pass through the filter at the junction of the glomerulus and Bowman's capsule. Better candidates appreciated that the basement membrane was the actual filter and that damage to this would result in proteins being allowed through so that they appeared in the urine. A minority thought that proteins did normally pass through the filter and that the person with the kidney disease was unable to reabsorb them.

Q7.

Metabolic water was a term well known to candidates. Some excellent answers here included the equation for aerobic respiration, although just the name of this process would have been sufficient. Many candidates typically scored just 1 mark as they failed to point out that the process was aerobic.

Q8.

(a) Although the definition in (i) produced a variety of responses, ranging from the short and precise to the lengthy and rambling, most were acceptable. Part (ii) was straightforward but two common errors were made, sometimes by good candidates. These were to give respiration or urination as responses. The hypothalamus was correctly identified by most candidates.

(b) Part (i) was well answered though it appeared some candidates may not have noticed the presence of this question at the bottom of the page. Candidates did not usually find (ii) easy. Many used almost all the space writing about ADH without using the required information from **Figure 1**. Where the role of the aquaporins was understood it was not always made explicit in answers. Osmosis was usually considered and most candidates also appreciated that the aquaporins are bound to the membrane facing the lumen of the collecting duct. However, answers which detailed the whole process were few and far between.

(c) Unfortunately, some candidates gave the impression of applying a prepared answer relating to the presence of glucose in the urine to this question and, obviously, gained no credit. The mark scheme allowed for all the major obvious symptoms and many of the better candidates obtained the mark.
Part (ii) produced good responses from the stronger candidates but very commonly weaker candidates did not appear to know that males had one X and one Y chromosome while females had two X chromosomes. The responses to (iii) were reasonable. The most common shortcoming was a failure to write in terms of probabilities with many candidates stating no more than that carriers of a recessive allele would reproduce while most of those with a dominant allele definitely would not reproduce. A handful of candidates thought that the question was looking for heterozygote advantage and answered in these terms.

Q9.

(a) Many candidates wrote at length but became so lost in their own argument that they did not cover all aspects of the question. Frequently, they did not state that the concentration of the urine would be increased in the presence of ADH and that its volume would be reduced. Most knew that ADH caused greater reabsorption of water, although a few were clearly confused, despite the evidence in the data.

(b) Nearly all realised that proteins, being large molecules, would not normally be present in urine and that, in the diseased kidney, they would be able to pass through the damaged filter and hence be detectable in the urine.

Q10.

(a) Many candidates were unable to give two correct polymers. Answers given were extremely varied and included starch, ammonia and lipids. A significant number of candidates gave protein and haemoglobin and were awarded one mark.

(b) Better candidates tended to write more concisely but still manage to gain most of the marks available. For part (ii) it was possible to answer the question and score full marks without describing all the events in the nephron.

(c) (i) This question was generally well answered.

(ii) Credit was given to all candidates who conveyed the idea of maintaining the concentration gradients. Incorrect responses generally stated that urea would flow back into the bloodstream after five hours or, that after five hours, the concentration of urea would rise to dangerously toxic levels.

(iii) Incorrect responses to this question showed some major misconceptions. It was clear from responses that some candidates assumed the kidneys were functioning normally in addition to the treatment or that the fluid was being administered into the kidneys.

Q11.

Candidates who were able to apply their knowledge of protein structure and water potential were rewarded with high scores. Unfortunately, many candidates of all abilities lost credit in part (b) by failing to direct their responses to the specific demands of the questions, preferring instead to rely on recall of more general knowledge of these two topics. Part (b) was commonly left unanswered by weaker candidates.

(a) Most candidates gained credit; the most common errors were to give the pancreas or hypothalamus.

(b) In part (i), only a minority of candidates appreciated the importance of protein tertiary structure, and even fewer related specificity of shape to the channel. It was more common to read of 'carriers' or 'active sites' that changed shape to allow water across the membrane. In part (ii), candidates generally appreciated that water movement was by osmosis and that a water potential difference was required. However, despite the wording of the question, a large number of candidates referred to water moving into the medulla and gave details of the loop of Henle and sodium ion concentration gradients without appreciating that movement is first into the cells of the collecting ducts. Poor expression also lost credit, for example 'water moves by osmosis into the collecting ducts', which was not clear enough to distinguish between the cells and the duct lumen. Disappointingly, despite clear reference to water potential as a required term throughout the specification, a number of candidates still referred to water concentration differences and osmotic and solute potential.

Q13.

(a) (i) Most candidates answered this correctly. There were a few who referred to the loop of Henle.

(ii) Most candidates gave the correct answer. Urea, water and glucose were the most common wrong answers.

(b) About half the candidates scored both marks. Of the rest, most scored one mark by starting the calculation correctly (usually dividing 75 by 60) but then multiplied rather than dividing for the second mark.

(c) This was well answered. Weaker candidates gave general answers about thin membranes, closeness to the blood, moist surfaces and small diffusion distances. Most common answers were about mitochondria and microvilli. Some failed to score marks by giving incomplete answers, with no reference to ATP or energy.

Q14.

This topic area seems generally well understood and many candidates were able to apply their knowledge effectively and gained credit. Careless use of terminology and lack of detail marred the answers of weaker candidates.

(a) The definition was well learnt by the majority of candidates although some missed the idea of keeping conditions constant or gave a named example rather than the definition.

(b) Generally this question was well answered but lack of precision in some answers cost candidates marks, for example, by failing to refer to receptors and/or identifying their location. Common misconceptions included the involvement of the pituitary and the hormone directly catalysing the conversion of glycogen to glucose thereby acting as an enzyme.

Weaker candidates confused glucagon with glycogen and usually scored only one mark for the idea of raising blood glucose levels. Diffusion of glucose out of cells into the blood was rarely seen.

(c) A surprisingly high proportion of candidates correctly used the information given in the stem of the question and their own knowledge to work out the clearance value for glucose and go on to obtain full marks. Many of those unsure of the maths did explain the mechanism of reabsorption of glucose in the kidney and gained two or three marks. The most common omission was to the principle of all the glucose

being reabsorbed and weaker candidates were also unsure of the precise location in the tubule where this process actually occurs.

Q15.

This question gave candidates the opportunity to display in-depth knowledge of a particular topic from the specification. Some answers were marred by lack of attention to detail and poor use of scientific terminology. The application of knowledge in part (b) proved to be a good discriminator.

(a) (i) A high-scoring question for those who had learnt it. The majority of students were well prepared and answers were logical and easy to follow. Very few, however, referred to the idea of the lower water potential in the cells of the medulla related to the length of the loop. Some candidates needed to make clearer the actual location of the processes they were describing and to avoid contradictory statements. The sloppy use of terminology such as “salts’ for ions also compromised the marks gained by some of the weaker candidates.

(ii) Well rehearsed answers were produced by the most of the candidates, although there were some unusual locations for the osmoreceptors.

(b) (i) Most candidates repeated the information from the diagram without reference to humans for comparison. The most common mark gained was for the conversion of ammonia to urea.

(ii) Very few candidates referred to the water potential of fresh water in comparison to cells but many either mentioned osmotic damage (although not using precise terminology) or excreting excess water and gained one mark. Answers written in terms of diluting the ammonia in the surroundings, either to avoid poisoning or to reduce pollution, did not gain credit.

Q16.

This question was generally well answered, the majority of candidates gaining at least three of the eight marks available. However, very few candidates gained maximum marks, mainly due to their inability to interpret the data provided in (d)(i).

(a) Most candidates gained this mark with urea and a named ion being the most common correct answers.

(b) This caused few difficulties with the vast majority of candidates obtaining both marks. Candidates gaining one mark often referred to less filtrate being formed but did not relate this to a decrease in blood pressure.

(c) Better candidates obtained both marks usually by explaining that the presence of microvilli increased surface area, and mitochondria provided ATP for active transport. Correct references to carrier proteins were also frequently credited. Weaker candidates mentioned ‘villi’, ‘a good blood supply’ and ‘thin membranes’.

(d) (i) This proved to be the most difficult part of this question. Although many candidates appreciated that the threshold value for glucose reabsorption had been reached, they misread the value as being 2.1 rather than 2.2. Very few candidates gained the mark for explaining why glucose above the threshold value could not be absorbed.

(ii) Most candidates correctly linked a raised plasma glucose concentration to either a decrease in insulin production, or less frequently, to damaged insulin

receptors.

Q17.

(a) The great majority correctly referred to ADH, although a sizeable minority suggested insulin.

(b) This part was generally done well, although a number carelessly described the glucose as being absorbed into the body rather than the blood. A few tried to involve insulin in their answer. Some were confused about the role of the proximal convoluted tubule and tried to explain the data in terms of ultrafiltration.

(c) It was encouraging to see a reasonable number of good accounts correctly describing the roles of the ascending and descending limbs of the loop of Henle. The majority, however, had very little idea of what happens to the sodium ions in the loop and many responses were very confused. Frequently the ions were described as diffusing against a concentration gradient, and many answers would have resulted in the opposite effect to that shown by the curve in the graph. Surprisingly few of even the better candidates clearly linked their answer to the shape of the curve, and, for instance, few related the peak to the high concentration at the base of the loop.

Q18.

(a) This question was a good discriminator, producing a full range of marks but relatively few candidates with all five. Many candidates displayed confusion about which processes occur in the loop of Henle and where. In addition, many ignored the instruction to explain how the loop maintains a gradient of ions and entered into general descriptions of the functions of the kidney tubule. Some candidates confused the functions of the loop of Henle and the collecting duct. Terminology was also a problem for some candidates, especially with regard to failure to refer to water potentials.

(b) This question was a good discriminator, producing a full range of marks but relatively few candidates with all four. Many candidates obtained one or 2 two marks, usually for references to release of ADH from the pituitary gland, the resulting increase in permeability of the collecting duct, or the reduced volume of urine produced (or the converse). There were good answers which followed the whole train of events, starting with the stimulus of a lowering of the water potential of the blood (or a rise, or a change in blood volume and pressure) and its detection by appropriate named receptors. These answers then linked these events to the roles of the hypothalamus and pituitary glands and the release (or reduced release) of ADH.

(c) This was not answered very well by most candidates, primarily because they did not appear to be able to compare the information in the diagram to what they were supposed to know about a simple reflex. It was particularly surprising how few made any reference to the autonomic ganglion shown in the diagram.

Q19.

This question, which required candidates to understand the rudiments of kidney and liver function, provided them with a simple graph to use as a source of evidence. Most candidates were able to gain the mark for (a)(i), giving kidney function as the removal of urea from the blood and explaining this using relevant evidence from the graph. Candidates found (a)(ii) more difficult, with a surprising number failing to realise that the function of the liver was the production of urea. Some who realised this were still unable to

justify their answers using evidence from the graph. A relatively large number of candidates confused deamination with urea production, although such a mistake did not necessarily preclude the award of the mark here. Part (b), in which candidates were required to predict the nature of the graph in different circumstances, proved too difficult for around half of the candidates. Up to two marks were available for part (b), with many candidates gaining both of these.