



2

Urine consists of water, ions and other substances such as urea.  
Urine is formed in the kidney by filtering the blood.  
The diameter of the pores in the filter is about 6 nanometres.

The table shows the diameters of the molecules of some of the substances in the blood.

Substance	Diameter of molecule in nanometres
A	10 to 20
B	1
C	0.6
D	0.5
E	0.2

Use information from the table and your own knowledge to answer the questions.

(a) (i) Which substance, **A**, **B**, **C**, **D** or **E**, is protein?

(1)

(ii) Protein is **not** found in the urine of a healthy person.

Explain why.

---

---

---

---

---

---

---

(2)

- (b) Substance **B** is **not** found in the urine of a healthy person.  
Suggest an explanation for this.

---

---

---

---

---

---

---

(2)

- (c) Haemolytic anaemia is a disease in which some of the red blood cells burst open.

Small amounts of haemoglobin may be found in the urine of a person suffering from haemolytic anaemia.

The diameter of a haemoglobin molecule is 5.5 nanometres.

Haemoglobin is **not** found in the urine of a healthy person, but haemoglobin can be found in the urine of a person with haemolytic anaemia.

Explain why.

---

---

---

---

---

---

---

---

---

---

(3)

(Total 8 marks)

**3**

- (a) Which organ in the body monitors the concentration of glucose (sugar) in the blood?

---

(1)

- (b) In a healthy person, insulin prevents high levels of glucose in the blood. To make insulin, cells in the pancreas need amino acids.

Amino acids cannot be stored in the body.

Describe, as fully as you can, what happens to amino acids that cannot be stored in the body.

---



---



---



---



---



---



---



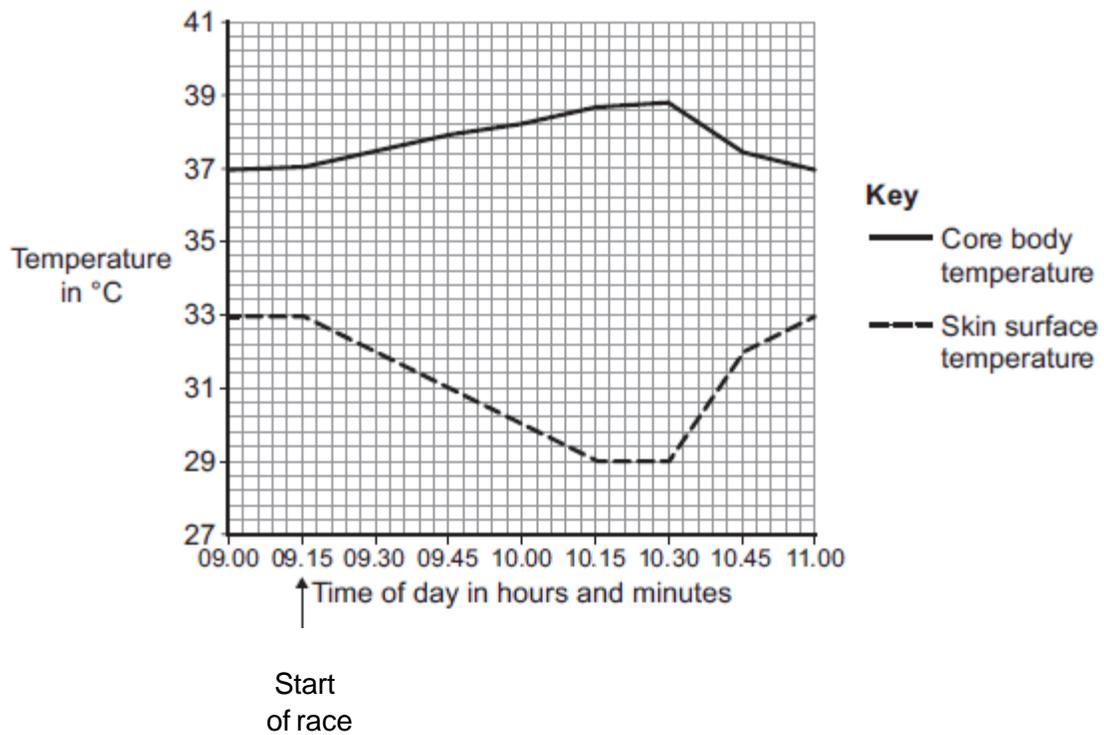
---

(3)

(Total 4 marks)

4

The graph shows the core body temperature and the skin surface temperature of a cyclist before, during and after a race.





(b) During the race, the cyclist's blood glucose concentration began to decrease.

Describe how the body responds when the blood glucose concentration begins to decrease.

---

---

---

---

---

---

---

---

---

---

**(3)**  
**(Total 12 marks)**

**5** Many runners drink sports drinks to improve their performance in races.

A group of students investigated the effects of three brands of sports drink, **A**, **B** and **C**, on the performance of three runners on a running machine. One of the runners is shown in the image below.



© Keith Brofsky/Photodisc/Thinkstock

**Table 1** gives information for each drink.

**Table 1**

	Brand of sports drink		
Nutrient per dm <sup>3</sup>	A	B	C
Glucose in g	63	31	72
Fat in g	9	0	2
Ions in mg	312	332	495

- (a) (i) In the investigation, performance was measured as the time taken to reach the point of exhaustion.

Exhaustion is when the runners could not run anymore.

All three runners:

- ran on a running machine until the point of exhaustion
- each drank 500 cm<sup>3</sup> of a different brand of sports drink
- rested for 4 hours to recover
- ran on the running machine again and recorded how much time they ran until the point of exhaustion.

The speed at which the runners ran was the same and all other variables were controlled.

The students predicted that the runner drinking brand **B** would run for the shortest time on the second run before reaching the point of exhaustion.

Use information from **Table 1** to suggest an explanation for the students' prediction.

---

---

---

---

**(2)**

- (ii) If the balance between ions and water in a runner's body is not correct, the runner's body cells will be affected.

Describe **one** possible effect on the cells if the balance between ions and water is **not** correct.

---

---

**(1)**

(b) When running, a runner's body temperature increases.

Describe how the brain monitors body temperature.

---

---

---

---

---

---

---

(3)

(c) (i) **Table 2** is repeated here to help you answer this question.

**Table 2**

	Brand of sports drink		
Nutrient per dm <sup>3</sup>	A	B	C
Glucose in g	63	31	72
Fat in g	9	0	2
Ions in mg	312	332	495

People with diabetes need to be careful about drinking too much sports drink.

Use information from **Table 2** to explain why drinking too much sports drink could make people with diabetes ill.

---

---

---

---

---

---

---

(3)

- (ii) Other than paying attention to diet, how do people with diabetes control their diabetes?

---

---

(1)

(Total 10 marks)

**6**

*In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.*

Homeostasis keeps conditions in the body relatively constant.

The amount of water in the body is controlled by homeostasis.

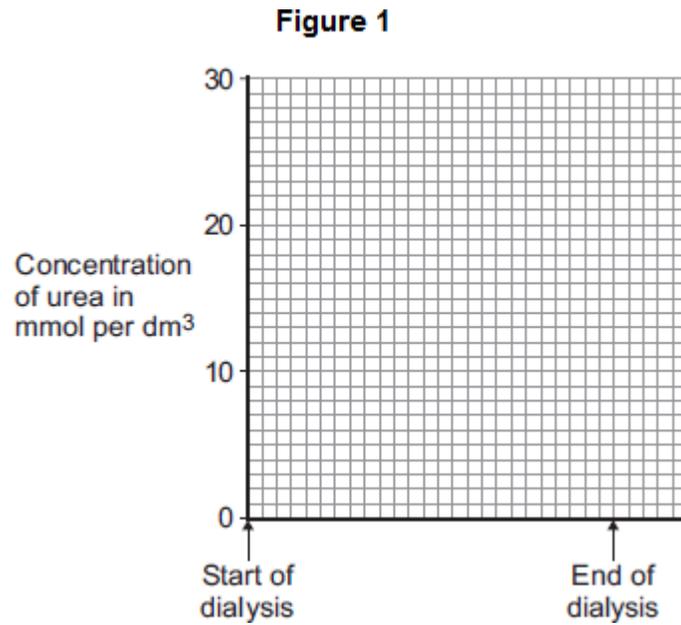
Kidney function is controlled by a gland in the brain.





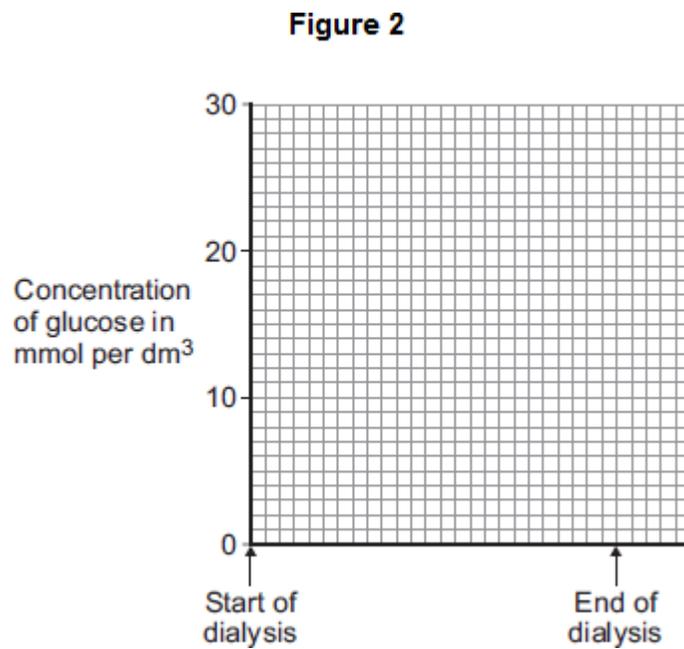
The child has a normal blood glucose concentration.

- (i) Sketch a graph on **Figure 1** to suggest what will happen to the concentration of urea in the blood during dialysis.



(1)

- (ii) Sketch a graph on **Figure 2** to suggest what will happen to the concentration of glucose in the blood during dialysis.



(1)

- (c) (i) Another way of treating kidney failure is with a kidney transplant.  
A transplanted kidney can be rejected.

Explain why the new kidney may be rejected.

---

---

---

---

---

---

---

(3)

- (ii) Describe **one** way in which doctors try to prevent kidney rejection.

---

---

(1)

(Total 11 marks)

## Mark schemes

- 1** blood vessels supplying skin 1
- constrict
- allow vasoconstriction*  
*do **not** allow capillaries /veins constricting*  
*do **not** allow moving blood vessel* 1
- less blood flow (to / through capillaries / to skin)  
*allow blood flows further away from skin surface* 1
- so less energy is lost (to the surroundings)  
*allow less heat is lost* 1
- 'shivering' by muscle (contraction)  
*allow muscles contract (and relax) rapidly* 1
- releasing energy **or** respiring (more)  
*allow 'heat produced'*  
*do **not** allow energy produced / made*  
*do **not** allow energy **for** respiration*  
*allow sweating stops / reduces*
- ignore hair erection* 1
- 2** (a) (i) **A** 1
- (ii) (protein) molecule is large  
*ignore letters* 1
- cannot pass through filter  
*(protein is) too big to get through the filter = 2 marks* 1
- (b) **B** is taken back into the blood **or**  
**B** is reabsorbed 1
- reabsorbed completely
- or** reabsorbed after filtration 1

**[6]**

(c) RBC is too big to pass through filter

1

Haemoglobin is inside red blood cells  
**or** haemoglobin released when RBC bursts

1

Haemoglobin is small enough to pass through filter

**or** haemoglobin diameter < pore diameter

1

[8]

3

(a) Pancreas

*allow phonetic spelling*

1

(b) any **three** from:

*max 2 if any one process goes on in wrong organ*

- (amino acids) broken down
- (amino acids) form urea
- (amino acids broken down / converted **or** urea formed) in liver
- (urea / broken down amino acids) removed / filtered by kidney  
*do not allow amino acids filtered / removed by kidney*
- (urine / urea / broken down amino acids) stored / held in bladder  
*do not allow amino acids stored / held in bladder*

3

[4]

4

(a) (i) 1 hour 15 mins / 1.25 hours / 75 mins

*allow 1:15*

*ignore 1.15 hours*

1

- (ii) increase in (core / body) temperature  
*ignore numbers* 1
- (due to an) increase in respiration **or** more muscle contraction 1
- releasing energy (as a waste product)  
*allow produces 'heat'*  
*do **not** allow making energy* 1
- skin temperature decreases 1
- (because there is) sweating 1
- (which) evaporates and cools the skin  
*ignore references to vasodilation or vasoconstriction* 1
- (iii) (there is) dilation of vessels (supplying skin capillaries)  
*allow vasodilation*  
*allow blood vessels widen*  
*ignore expand*  
*do **not** accept dilating capillaries or moving vessels* 1
- (so) more blood flows (near skin) (surface) **or** blood is closer (to the skin)  
*ignore ref to heat* 1
- (c) pancreas detects (low) blood glucose 1
- produces glucagon  
*do **not** allow glucagon made in the liver* 1
- (so) glycogen is converted to glucose  
*allow adrenaline released which increases conversion of glycogen to glucose*  
**or**  
*reduced insulin production so less glucose into cells / less glucose converted to glycogen*  
*for 1 mark* 1

[12]

- 5 (a) (i) has the least amount of glucose  
*allow least amount of fat **or** no fat* 1
- (to) transfer energy (for the run)  
*allow (to) release energy (for the run)*  
*do **not** allow produces energy*  
*do **not** allow 'energy for respiration'* 1
- (ii) any **one** from:  
• cells will work inefficiently  
• absorb too much water / swell / overhydrate  
• lose too much water / shrink / dehydrate  
*ignore turgid / flaccid*  
*cells burst is insufficient*  
*allow cramp in muscle.* 1
- (b) any **three** from:  
• thermoregulatory centre  
• (has temperature) receptors  
• (which) monitor blood temperature (as it flows through the brain)  
• (temperature) receptors in the skin  
• (receptors) send impulses to the brain  
*ignore vasoconstriction / vasodilation / sweating*  
*allow hypothalamus*  
*impulses sent to the thermoregulatory centre = 2 marks.* 3

(c) (i) (sports drinks) contain a lot of glucose

1

(a person with diabetes) does not produce insulin **or** does not produce enough insulin

*allow (person with diabetes) has cells which do not respond to insulin*

*do **not** allow insulin produced by liver*

1

so blood glucose / sugar levels will rise too high **or** to a dangerous level

1

(ii) inject insulin

**or**

have an insulin pump (fitted)

*do **not** allow swallow insulin*

*accept exercise*

*accept inhale insulin*

*accept take metformin **or** other correctly named drug*

*allow pancreatic transplant*

1

[10]

**6** Marks awarded for this answer will be determined by the Quality of Communication (QC) as well as the standard of the scientific response. Examiners should also refer to the information on page 5, and apply a 'best-fit' approach to the marking.

**0 marks**

No relevant content.

**Level 1 (1 – 2 marks)**

There is a brief description of kidney function including a mention of pituitary gland **or** hormones but roles may be confused.

**Level 2 (3 – 4 marks)**

There is a clear description of kidney function in relation to fluctuations in blood water levels and the roles of the pituitary gland **or** hormone is mentioned with correct role.

**Level 3 (5 – 6 marks)**

There is a clear and detailed scientific description of kidney function in relation to fluctuations in blood water levels and of the roles of the pituitary gland and ADH.

**examples of biology points made in the response:**

- if water content too low, ADH released
- from pituitary gland
- into the blood
- (causing) kidney reabsorbs more water
- more concentrated / small volume urine produced
- if water content too high, ADH lowered / not produced
- less water reabsorbed by kidney
- more dilute / larger volume urine produced

*full marks may be awarded for detailed description of either water loss or gain*

**[6]**

**7** (a) (the kidney) filters the blood  
*ignore refs to hormones and drugs*

1

(and then) reabsorbs all of the glucose

1

reabsorbs some of the ions

*allow salts*

*ignore minerals*

1

reabsorbs some of the water

1

releases urea (in urine)

1

- (b) (i) should fall from 28 (to the end of dialysis)  
*ignore any line drawn after end of dialysis*  
*allow + / - 0.5 square*  
*graph line must fall to / below*  
*below 15* 1
- (ii) should stay level at about 6 throughout  
*ignore slight variations*  
*allow + / - 1 square*  
*ignore any line drawn after end of dialysis* 1
- (c) (i) immune system 1  
*allow white blood cells / lymphocytes* 1
- (produces) antibodies 1
- (which) attack the antigens (on the transplanted kidney)  
*non-matching antigens insufficient* 1
- (ii) any **one** from:  
  - tissue typing (to find match)
  - treating with drugs that suppress the immune system*accept treat with immunosuppressants.* 1

[11]