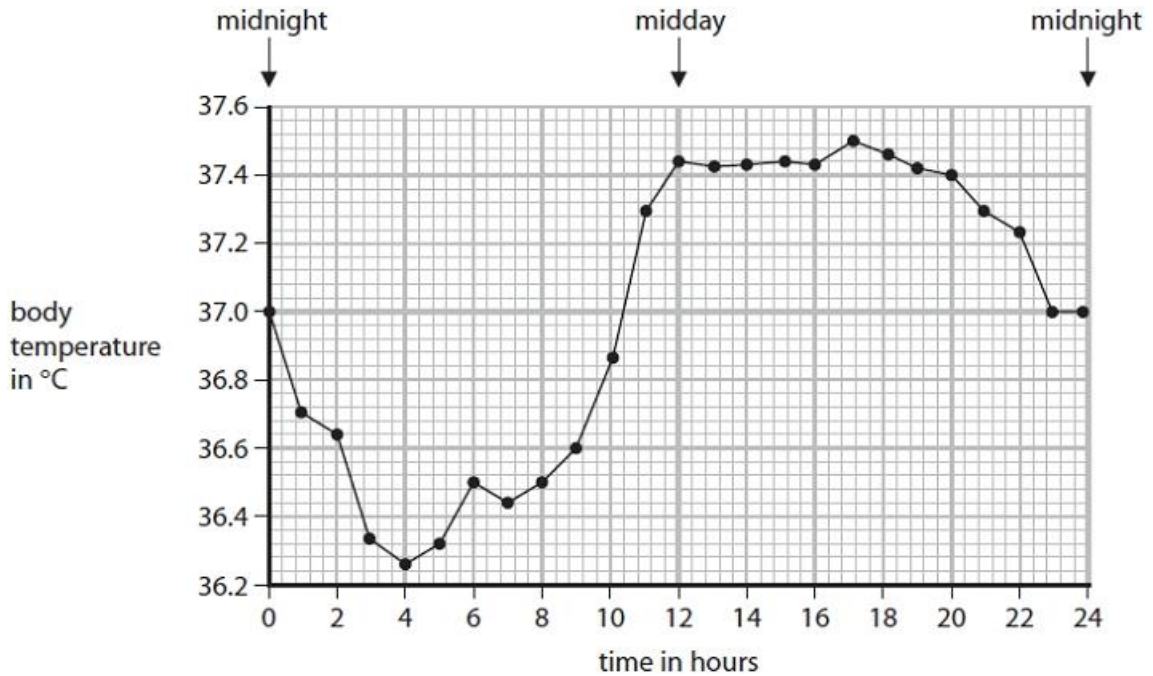


**Questions**

Q1.

Figure 4 shows a person's body temperature during 24 hours.



**Figure 4**

(i) State this person's highest body temperature.

(1)

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(ii) Explain the change in body temperature from 0 hours to 4 hours.

(3)

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**(Total for question = 4 marks)**

**Q2.**

When training, an athlete noticed some types of T-shirts became wetter and heavier due to sweating.

This athlete has three T-shirts, each made of a different material.

Devise a method this athlete could use to find the best T-shirt for training.

**(3)**

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**(Total for question = 3 marks)**

**Q3.**

\* It is estimated that about 3 million people in the UK are at risk of developing chronic kidney disease (CKD).

The most severe stages of CKD can result in kidney failure.

Discuss the use of different treatments for kidney failure.

**(6)**

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**(Total for question = 6 marks)**

**Q4.**

Excessive weight gain and obesity increase the likelihood of developing type 2 diabetes.

Explain the effect of type 2 diabetes on the body.

**(3)**

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**(Total for question = 3 marks)**

**Q5.**

Explain how high levels of amino acids in the blood cause a high concentration of urea in urine.

**(4)**

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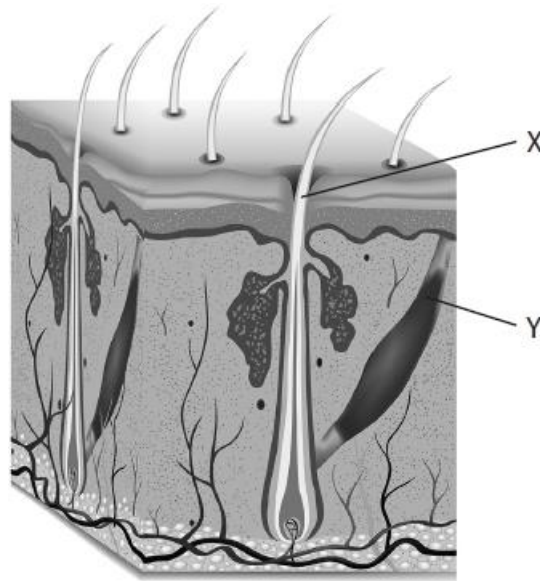
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**(Total for question = 4 marks)**

Q6.

Figure 3 shows a section through the skin.



(Source: © mariyaermolaeva/Shutterstock)

Figure 3

The skin helps to keep body temperature constant.

(i) Which is the correct term for maintaining a constant internal environment?

(1)

- A excretion
- B homeostasis
- C respiration
- D sweating

(ii) Explain how structures X and Y help to regulate body temperature when the body is too cold.

(2)

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(iii) Explain how shivering can help a person regulate their body temperature.

(2)

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**(Total for question = 5 marks)**

Q7.

Figure 12 shows the urinary system of a mammal.

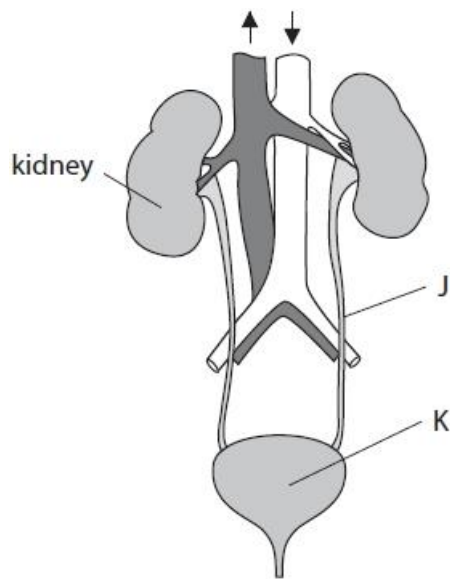


Figure 12

Name structure J and structure K.

(2)

Structure J .....

Structure K .....

**(Total for question = 2 marks)**



**Q8.**

Nephrons in the kidney filter the blood to produce urine.

Urine contains urea.

(i) What is urea made from?

(1)

- A** excess amino acids
- B** excess carbohydrates
- C** excess vitamins
- D** excess lipids

(ii) Figure 13 shows which components of the blood are filtered into the nephron.

blood component	is the component filtered into the nephron?
blood cells	no
large proteins	no
glucose	yes
sodium ions	yes

**Figure 13**

Explain the conclusions that can be made from this information.

(2)

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**(Total for question = 3 marks)**

Q9.

Figure 16 shows the urinary system of a human.

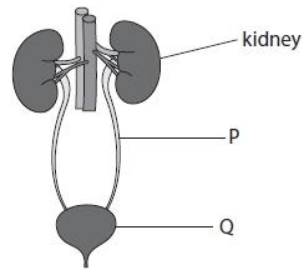


Figure 16

\* Figure 18 shows a patient undergoing kidney dialysis.

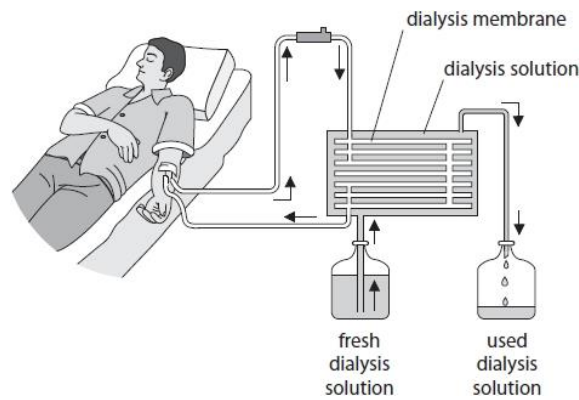


Figure 18

Describe how dialysis removes unwanted substances from the blood.  
Include examples of unwanted substances in your answer.

(6)

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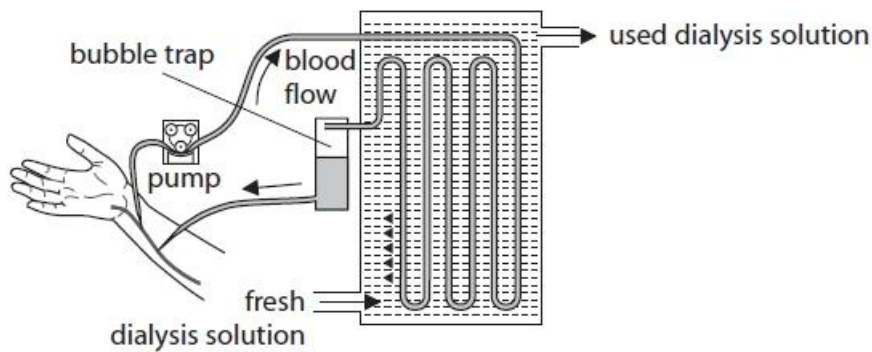
(Total for question = 6 marks)

**Q10.**

A patient cannot remove enough urea from the blood when making urine.

Figure 22 shows a dialysis machine attached to the arm of this patient.

Their blood is pumped out of their arm, passed through the dialysis machine, and then put back into the patient.



**Figure 22**

(i) Describe what happens to urea as the blood passes through the dialysis machine.

(2)

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(ii) Two patients need to have dialysis treatment.

Patient A needs this treatment three times a week.

Patient B needs this treatment once a week.

Give **one** reason why patient B needs dialysis treatment less often than patient A.

(1)

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**(Total for question = 3 marks)**

**Q11.**

A person had symptoms including difficulty passing urine, aching in the lower abdomen, constant thirst and fainting.

A sample of their urine was tested.  
The results are shown in Figure 8.

test	result	acceptable range
Glucose	200 mg per dl	0 to 130 mg per dl
Albumin (protein)	16 mg per dl	0 to 3 mg per dl
pH	3	5 to 7
Leukocytes (white blood cells)	40	2 to 5

**Figure 8**

(i) A doctor analysed the results and asked the person to have further tests for type 2 diabetes.

Give a reason why the doctor came to this conclusion.

(1)

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(ii) Explain why the doctor also concluded that the person had a kidney infection.

(2)

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**(Total for question = 3 marks)**

**Q12.**

Person B needs a kidney transplant.  
Person B has a twin sister.

Explain why this twin sister could be a suitable kidney donor for Person B.

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**(Total for question = 2 marks)**

## Q13.

The concentration of protein in urine from person A and person B was measured each year from 2015 to 2019.

Person A had healthy kidneys. Person B had kidney disease.

year	concentration of protein in urine in arbitrary units	
	person A (with healthy kidneys)	person B (with kidney disease)
2015	2	25
2016	4	37
2017	5	57
2018	4	79
2019	3	106

Figure 15

Use the data in Figure 15 to compare the changes in the concentration of protein in the urine from person A and person B.

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(Total for question = 2 marks)

**Q14.**

People with a high BMI are more likely to develop type 2 diabetes.  
Figure 11 shows the mass, height and BMI for two people.

person	mass in kilograms	height in metres	BMI
A	110	2.0	?
B	85	1.5	38

**Figure 11**

(i) Use the formula to calculate the BMI for person A

$$\text{BMI} = \frac{\text{mass}}{\text{height}^2}$$

(2)

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(ii) Person B develops type 2 diabetes.

Describe **two** lifestyle changes person B should make to help to control their blood glucose concentration.

(2)

1 .....

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2 .....

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**(Total for question = 4 marks)**

**Q15.**

(i) The scientist also measured the BMI of the females.

BMI and waist to hip ratio are two factors that affect the probability of females developing type 2 diabetes.

State **two** other factors about the females in the study that would affect the probability of them developing type 2 diabetes.

(2)

1 .....

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2 .....

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(ii) State why an athlete may have a high BMI but still have a low probability of developing type 2 diabetes.

(1)

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**(Total for question = 3 marks)**



**Q16.**

Blood samples were taken from this patient every four hours.

The glucose concentrations were recorded in Figure 11.

time in hours	blood glucose concentration in milligrams per decilitre
0	100
4	131
8	139
12	90
16	92
20	134
24	137

**Figure 11**

(i) Describe the trends shown in this data.

(3)

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(ii) This patient was diagnosed as being type 2 diabetic.

Explain why the blood glucose concentration of this patient remained high from 4 hours to 8 hours.

(3)

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(iii) This patient did some exercise during these 24 hours.

Explain how the data in Figure 11 shows that this exercise occurred after 8 hours but before 12 hours.

(3)

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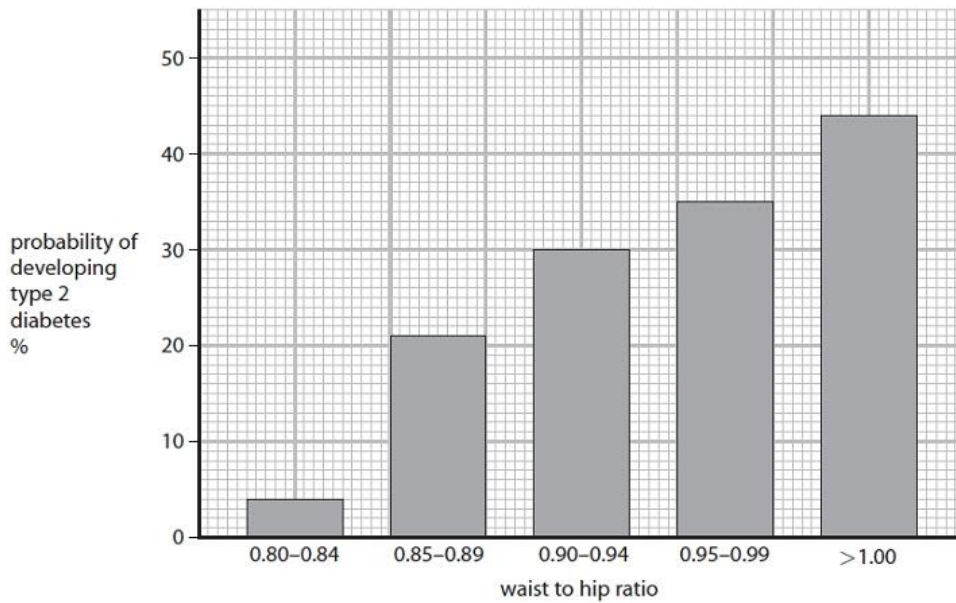
**(Total for question = 9 marks)**

**Q17.**

A scientist investigated how the waist to hip ratio affected the probability of developing type 2 diabetes.

The scientist chose 100 females in each of five waist to hip ratio groups and recorded if they developed type 2 diabetes.

Figure 7 shows the results.



**Figure 7**

(i) Describe the trend shown in Figure 7.

Use data from Figure 7 in your answer.

(2)

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(ii) A female has a waist measurement of 78.3 cm and a hip measurement of 90.0 cm.

Calculate the waist to hip ratio for this female and use Figure 7 to estimate the probability that she will develop type 2 diabetes.

(2)

probability ..... %

**(Total for question = 4 marks)**

**Q18.**

Insulin is produced by an endocrine gland and is transported in the blood.

Explain how controlling the diet can be used to treat type 2 diabetes.

(2)

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**(Total for question = 2 marks)**

**Q19.**

Excessive weight gain and obesity increase the likelihood of developing type 2 diabetes.

Explain the effect of type 2 diabetes on the body.

(3)

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**(Total for question = 3 marks)**

**Q20.**

Diabetics cannot effectively control the concentration of glucose in their blood.

Person A has type 1 diabetes.

Person B has type 2 diabetes.

Draw one straight line from each person to the cause of their type of diabetes.

(2)

person	cause
<div style="border: 1px solid black; padding: 5px; display: inline-block;">person A (type 1) •</div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">• does not have a pancreas</div>
	<div style="border: 1px solid black; padding: 5px; display: inline-block;">• cannot digest fatty foods</div>
	<div style="border: 1px solid black; padding: 5px; display: inline-block;">• does not produce insulin</div>
<div style="border: 1px solid black; padding: 5px; display: inline-block;">person B (type 2) •</div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">• has cells that have stopped responding to insulin</div>
	<div style="border: 1px solid black; padding: 5px; display: inline-block;">• cannot transport insulin in the blood</div>

**(Total for question = 2 marks)**

**Q21.**

Insulin is produced by an endocrine gland and is transported in the blood.

State **one** cause of type 1 diabetes.

(1)

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**(Total for question = 1 mark)**

**Q22.**

Insulin is produced by an endocrine gland and is transported in the blood.

A scientist is planning to test a new treatment for type 2 diabetes.

She selects 300 volunteers who have type 2 diabetes.

State **two** other factors that the scientist should consider when selecting the 300 volunteers.

(2)

1 .....

2 .....

**(Total for question = 2 marks)**

Q23.

Figure 7 shows how the internal temperature of a fish and an otter changes when the external temperature changes.

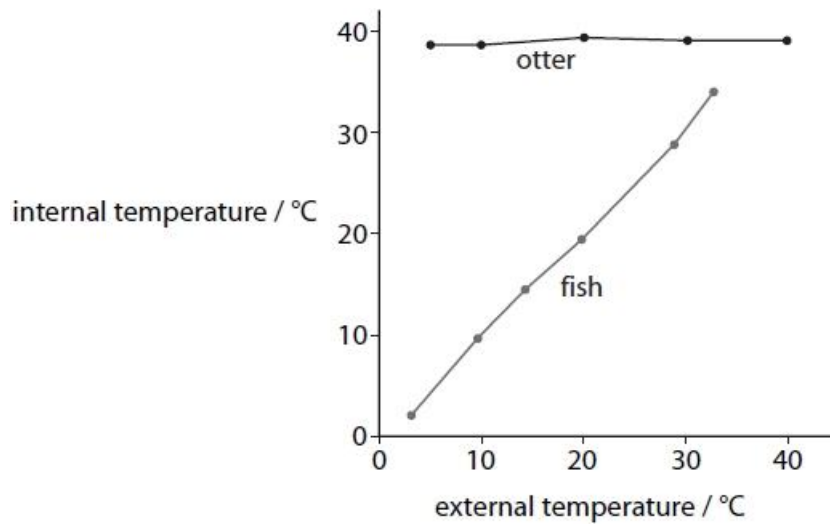


Figure 7

(i) Describe how the internal temperature of the fish changes in response to the external temperature.

(2)

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(ii) Explain why it is important that the temperature of the otter is maintained at about 37°C.

(2)

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(Total for question = 4 marks)

**Q24.**

Iguanas are lizards.

Some species of iguana live on hot islands in the Pacific Ocean and use the environment to regulate their body temperature.

Figure 11 shows an iguana on a rock in the sunshine.



© benjamint444/Getty Images

**Figure 11**

A marine biologist measured the oxygen consumption of an iguana at different temperatures.

Figure 12 shows the results.

body temperature of the iguana in °C	oxygen consumption in cm <sup>3</sup> per gram per hour
20	0.4
25	0.8
30	1.1
35	1.4

**Figure 12**

(i) Describe how the body temperature of the iguana affects its oxygen consumption.

(1)

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(ii) Explain why the body temperature of the iguana affects its oxygen consumption.

(3)

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(iii) Iguanas do not have sweat glands.

When an iguana is too hot, it pants by opening its mouth to cool down.  
Explain how this behaviour helps to cool the iguana down.

(2)

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**(Total for question = 6 marks)**

**Q25.**

Shivering is one way in which humans can regulate their body temperature.

Explain how shivering helps to regulate body temperature.

(3)

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**(Total for question = 3 marks)**

**Q26.**

Explain how sweating helps to cool the body.

**(2)**

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**(Total for question = 2 marks)**

**Q27.**

The kangaroo rat is a mammal that can survive in desert environments and can tolerate much higher concentrations of sodium ions in their bloodstream than humans.

Figure 16 shows an image of the kangaroo rat.



(Source: Richard R. Hansen/Science Photo Library)

**Figure 16**

(a) The name of the process that controls water levels in the body is

(1)

- A** diffusion
- B** osmosis
- C** osmoregulation
- D** thermoregulation

(b) (i) Explain how the blood entering the nephron of the kangaroo rat is filtered to remove excess sodium ions and water.

(3)

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The kangaroo rat has a longer loop of Henle than most mammals.

(ii) Explain why this adaptation is beneficial to the kangaroo rat.

(2)

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The volume of ADH stored in the pituitary gland of the kangaroo rat was measured. Figure 17 shows the average results for 500 kangaroo rats.

concentration of sodium chloride fed to kangaroo rats (mol dm <sup>-3</sup> )	volume of ADH stored in the pituitary gland (arbitrary units)
0.00	45
0.25	40
0.50	10
0.75	8
1.00	8

Figure 17

\*(iii) Explain how ADH helps to control the levels of water and sodium ions in the bloodstream.

(6)

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(Total for question = 12 marks)

**Q28.**

Explain why it is important to control the internal temperature of the human body.

(2)

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**(Total for question = 2 marks)**

Q29.

Answer the question with a cross in the box you think is correct . If you change your mind about an answer, put a line through the box  and then mark your new answer with a cross .

The human body can regulate the temperature of the blood.

(i) Which part of the brain controls body temperature?

(1)

- A cerebral hemispheres
- B medulla oblongata
- C cerebellum
- D hypothalamus

\*(ii) Figure 17 shows a diagram of the skin.

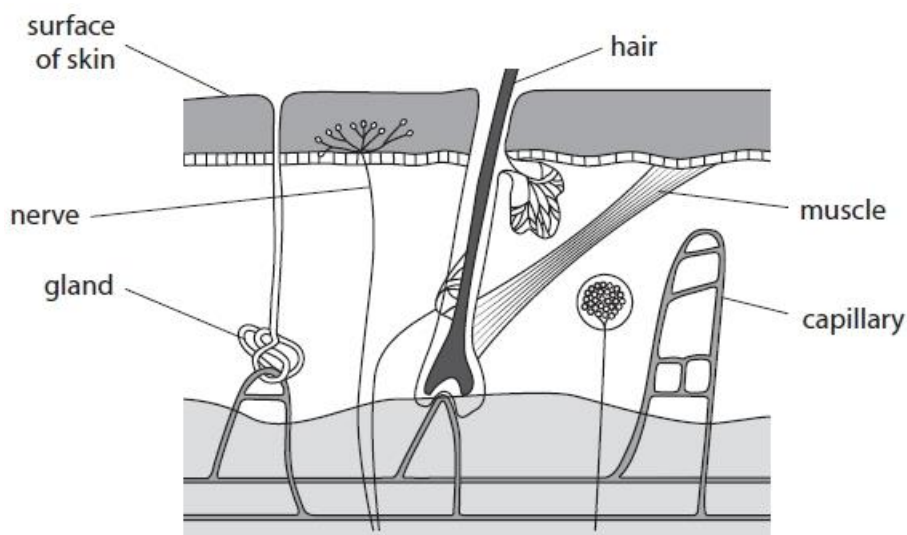


Figure 17

Explain how structures in the skin help to reduce body temperature during hot weather.

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**(Total for question = 7 marks)**

**Q30.**

Which part of the brain controls internal body temperature?

(1)

- A** cerebellum
- B** medulla oblongata
- C** hypothalamus
- D** pituitary gland

**(Total for question = 1 mark)**

**Q31.**

(i) Where in the human brain is the thermoregulatory centre?

(1)

- A** cerebellum
- B** cerebral cortex
- C** hypothalamus
- D** pituitary gland

(ii) Explain the role of vasodilation in thermoregulation.

(4)

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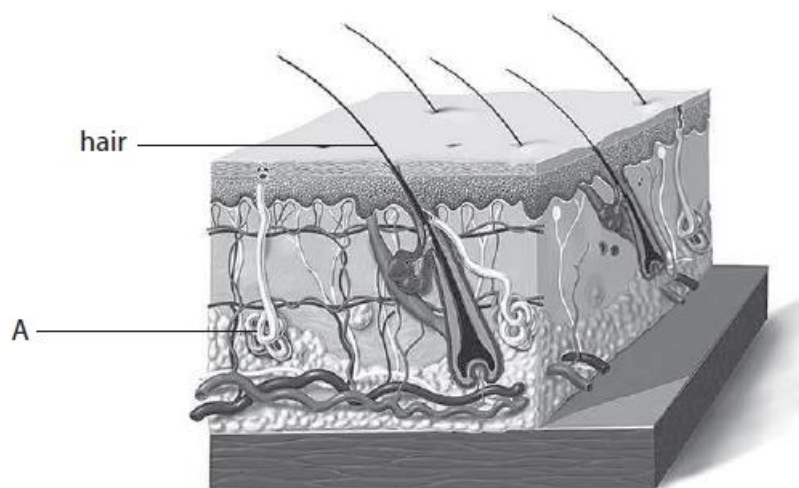
**(Total for question = 5 marks)**



**Q32.**

Thermoregulation is an important process of the human body.

Figure 6 shows a model of human skin.



**Figure 6**

(a) Explain how part A is involved in thermoregulation.

(2)

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(b) Which part of the brain contains the thermoregulatory centre?

(1)

- A** cerebellum
- B** cerebral cortex
- C** hypothalamus
- D** medulla

**(Total for question = 3 marks)**

**Mark Scheme**

Q1.

Question Number	Answer	Mark
(i)	37.5 °C	<b>(1)</b> <b>AO3 1a</b>
Question Number	Answer	Mark
(ii)	An explanation including: <ul style="list-style-type: none"><li>• there is a decrease in temperature (between 0 - 4 hours) (1)</li><li>• because the body is at rest / asleep (1)</li><li>• lower rate of respiration / less heat energy (generated / released) (1)</li></ul>	<b>(3)</b> <b>AO3 2a 2b</b>

Q2.

Question Number	Answer	Additional Guidance	Mark
	<p>An answer including <b>three</b> from:</p> <ul style="list-style-type: none"><li>• complete the same exercise (1)</li><li>• in the same environmental conditions (1)</li><li>• measure the change in mass for each T-shirt (1)</li><li>• the {least / most} weight gain is the best for exercise (1)</li></ul> <p><b>OR</b></p> <ul style="list-style-type: none"><li>• wet each T-shirt (1)</li><li>• with the same volume of water (1)</li><li>• measure the change in mass for each T-shirt (1)</li><li>• the {least / most} weight gain is the best for exercise (1)</li></ul>	<p>accept the same time of day / weather / temperature</p>	<p><b>(3)</b> <b>AO3 3a</b></p>

Q3.

Question Number	Indicative content	Mark
*	<p><b>General</b></p> <ul style="list-style-type: none"> <li>• Kidney failure is when you can no longer move sufficient urea out of the body.</li> <li>• Improve health / diet eg less salt / take more exercise</li> <li>• You can live on just one kidney</li> </ul> <p><b>Treatment 1 dialysis</b></p> <ul style="list-style-type: none"> <li>• waste substances removed / filtered from blood by dialysis machine</li> <li>• blood and dialysis fluid separated by partially permeable membrane</li> </ul> <p><b>Consequences / requirements</b></p> <ul style="list-style-type: none"> <li>• urea / other substances removed / water balance of body restored to normal</li> <li>• medication can be administered at the same time</li> <li>• increased risk of eg infection / low blood pressure</li> <li>• regular trips to hospital / need a (dialysis) machine at home</li> <li>• patients return to good health / live a normal life</li> </ul> <p><b>Treatment 2 organ donation</b></p> <ul style="list-style-type: none"> <li>• a healthy kidney is used to replace the damaged kidney by an operation</li> </ul> <p><b>Consequences / requirements</b></p> <ul style="list-style-type: none"> <li>• not enough healthy kidneys available / may have to wait a kidney becomes available</li> <li>• requires a suitable donor / risk of rejection / tissue matching</li> <li>• not appropriate if patient is too weak</li> <li>• need to take immunosuppressant drugs</li> <li>• patients return to good health / live a normal life</li> </ul>	(6) AO1 1

Level	Mark	Descriptor
	0	<ul style="list-style-type: none"><li>• No rewardable material.</li></ul>
Level 1	1-2	<ul style="list-style-type: none"><li>• Demonstrates elements of biological understanding, some of which is inaccurate. Understanding of scientific, enquiry, techniques and procedures lacks detail.</li><li>• Presents a description which is not logically ordered or with significant gaps.</li></ul>
Level 2	3-4	<ul style="list-style-type: none"><li>• Demonstrates biological understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific, enquiry, techniques and procedures is not fully detailed and/or developed.</li><li>• Presents a description of the procedure that has a structure which is mostly clear, coherent and logical with minor steps missing.</li></ul>
Level 3	5-6	<ul style="list-style-type: none"><li>• Demonstrates accurate and relevant biological understanding throughout. Understanding of scientific, enquiry, techniques and procedures is detailed and fully developed.</li><li>• Presents a description that has a well-developed structure which is clear, coherent and logical.</li></ul>

Level	Mark	Additional Guidance	General additional guidance The level is determined by the treatments covered in the response. The mark within the level is determined by linking the treatments to the consequences /requirements of the treatments.
	0	No rewardable material	<u>Possible candidate responses</u>
Level 1	1-2	<ul style="list-style-type: none"> <li>• makes a simple statement about kidney failure or type of treatment of kidney failure or states both types of treatment for kidney failure</li> </ul>	<ul style="list-style-type: none"> <li>• you can have an organ transplant</li> <li>• you have a transplant, or you have kidney dialysis</li> </ul>
Level 2	3-4	<ul style="list-style-type: none"> <li>• describes one consequence of one type of kidney failure and refers to the other type of treatment</li> <li>• describes more than one consequence of a treatment and refers to the other type of treatment OR describes one consequence of both types of treatment for kidney failure</li> </ul>	<ul style="list-style-type: none"> <li>• You can have a failed kidney replaced with one from someone else or have your blood cleaned by a machine.</li> <li>• You can have an organ transplant, but you have to wait for a suitable kidney which has to be matched so you don't reject it.</li> </ul>
Level 3	5-6	<ul style="list-style-type: none"> <li>• Describes more than one consequence of one type of kidney failure and one consequence of the other</li> <li>• One of the descriptions is detailed</li> </ul>	<ul style="list-style-type: none"> <li>• You go to hospital for dialysis. You may get an infection but you can live a normal life. For a transplant you may have to wait for a kidney.</li> <li>• both kidney transplant and dialysis let you can live a normal life but there is a waiting list for a kidney donor as they must match the new kidney to you, so you don't reject it.</li> </ul>

Q4.

Question Number	Answer	Additional Guidance	Mark
	<p>An explanation linking:</p> <ul style="list-style-type: none"><li>• blood glucose levels are not regulated / high (1)</li><li>• because cells are resistant to insulin (1)</li><li>• (so the liver) does not convert glucose to glycogen (1)</li></ul>	<p>accept blood sugar levels</p> <p>accept there is insulin resistance / unresponsive to insulin reject immune</p> <p>accept hyperglycaemia / symptoms of hyperglycaemia (1)</p>	<p><b>(3)</b> <b>AO1</b></p>



Q5.

Question Number	Answer	Additional guidance	Mark
	<p>An explanation linking <b>four</b> from:</p> <ul style="list-style-type: none"> <li>• because excess amino acids are broken down into urea (1)</li> <li>• amino acids broken down in the liver (1)</li> <li>• it is then transported in the blood to the kidney (1)</li> <li>• enter the nephron (1)</li> <li>• during ultrafiltration (1)</li> <li>• pass through the nephron / not reabsorbed back into the blood (1)</li> <li>• (so urine with a high concentration of urea) forms in the collecting duct (1)</li> </ul>	<p>accept deamination</p> <p>accept named blood vessels</p> <p>accept Bowman's capsule / renal capsule / glomerulus</p> <p>accept bladder for collecting duct</p>	<p><b>(4)</b> <b>AO1 1</b></p>

Q6.

Question Number	Answer	Mark
(i)	<p><b>B homeostasis</b></p> <p><b>The only correct answer is B</b></p> <p><i>A is not correct because excretion is not the correct term for maintaining a constant internal environment</i></p> <p><i>C is not correct because respiration is not the correct term for maintaining a constant internal environment</i></p> <p><i>D is not correct because sweating is not the correct term for maintaining a constant internal environment</i></p>	<p><b>(1)</b> <b>AO1 1</b></p>



Question Number	Answer	Mark
(ii)	<p>An explanation linking two from:</p> <ul style="list-style-type: none"> <li>• Y / muscle contracts (1)</li> <li>• X / hair stands up (1)</li> <li>• (more / a thicker (insulating layer of) air trapped (close to the skin) (1)</li> <li>• less heat leaves / escapes (from the skin) (1)</li> <li>• by convection / radiation (1)</li> </ul>	(2) AO1 1

Question Number	Answer	Mark
(iii)	<p>An explanation including two from:</p> <ul style="list-style-type: none"> <li>• (uncontrolled) muscle contraction (1)</li> <li>• heat generated (1)</li> <li>• so body temperature increases / becomes warmer (1)</li> </ul>	(2) AO1 1

Q7.

Question Number	Answer	Mark
	<p>J - ureter (1)</p> <p>K - bladder (1)</p> <p>Accept ureta Do not accept urethra, uthra</p>	(2) AO1 1

Q8.

Question Number	Answer	Mark
(i)	<p>A <b>excess amino acids</b></p> <p><b>The only correct answer is A</b></p> <p><i>B is not correct because urea is not made from excess carbohydrates</i></p> <p><i>C is not correct because urea is not made from excess vitamins</i></p> <p><i>D is not correct because urea is not made from excess lipids</i></p>	<p><b>(1)</b> <b>AO1 1</b></p>

Question Number	Answer	Mark
(ii)	<p>An explanation including two from:</p> <ul style="list-style-type: none"> <li>• blood cells / large proteins (are not found in the filtrate because they) are too large (1)</li> <li>• to pass through nephron wall / capillary / Bowman's capsule (1)</li> <li>• glucose / sodium ions are small enough (1)</li> <li>• to pass through nephron wall / capillary / Bowman's capsule (1)</li> </ul>	<p><b>(2)</b> <b>AO3 2a 2b</b></p>

Q9.

Question number	Indicative content	Mark
*	<p>Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme.</p> <p>The indicative content below is not prescriptive and candidates are not required to include all the material that is indicated as relevant. Additional content included in the response must be scientific and relevant.</p> <p><b>Blood to machine</b></p> <ul style="list-style-type: none"> <li>• kidney dialysis is used when a person's kidneys are damaged / don't remove urea from blood</li> <li>• blood taken from arm / passes into the dialysis machine</li> <li>• blood is separated from the dialysis solution by a (partially permeable) membrane</li> <li>• blood returned to body</li> </ul> <p><b>Unwanted substances</b></p> <ul style="list-style-type: none"> <li>• toxic substances</li> <li>• for example urea / alcohol</li> <li>• excess ions / named ions e.g. sodium and chloride</li> </ul> <p><b>How substances are removed from blood</b></p> <ul style="list-style-type: none"> <li>• (unwanted substances) move into the dialysis fluid</li> <li>• by diffusion across the membrane</li> <li>• down a concentration gradient</li> <li>• fresh dialysis fluid is pumped through to maintain the concentration gradient</li> </ul>	(6) AO 1 1

Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1-2	<ul style="list-style-type: none"> <li>• Demonstrates elements of biological understanding, some of which is inaccurate. Understanding of scientific ideas lacks detail</li> <li>• Presents an explanation with some structure and coherence</li> </ul>
Level 2	3-4	<ul style="list-style-type: none"> <li>• Demonstrates biological understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas is not fully detailed and fully developed.</li> <li>• Presents an explanation that has a structure which is mostly clear, coherent and logical.</li> </ul>
Level 3	5-6	<ul style="list-style-type: none"> <li>• Demonstrates accurate and relevant biological understanding throughout. Understanding of the scientific ideas is detailed and fully developed.</li> <li>• Presents an explanation that has a well-developed structure which is clear, coherent and logical.</li> </ul>

Q10.

Question Number	Answer	Additional guidance	Mark
(i)	<p>A description including:</p> <ul style="list-style-type: none"> <li>• blood is filtered (in a dialysis machine) (1)</li> <li>• urea moves {out of the blood / into dialysis solution} (1)</li> <li>• by diffusion (1)</li> </ul>	accept tube for blood	(2)  AO2 1

Question Number	Answer	Additional guidance	Mark
(ii)	<p>Any <b>one</b> from:</p> <ul style="list-style-type: none"> <li>• patient B has {kidney failure / disease} which is less advanced than patient A (1)</li> <li>• patient B may have a {better diet / low protein diet} (1)</li> </ul>	accept patient B only just developed kidney disease	(1)  AO2 1

Q11.

Question number	Answer	Additional guidance	Mark
(i)	excess glucose (in the urine) / (symptom of) constant thirst / fainting	reject albumin /leukocytes	(1) AO3 2a

Question number	Answer	Additional guidance	Mark
(ii)	<p>An explanation linking:</p> <ul style="list-style-type: none"> <li>• protein levels were above the normal range (1)</li> <li>• indicating bacteria / pathogens present (1)</li> </ul> <p>OR</p> <ul style="list-style-type: none"> <li>• leukocytes were above the normal range / 40 leukocytes (1)</li> <li>• indicating bacteria / pathogens present (1)</li> </ul>	<p>reject pH levels</p> <p>reject pH levels</p>	(2) AO3 2b

Q12.

Question number	Answer	Additional Guidance	Mark
	<p>An explanation including two from:</p> <ul style="list-style-type: none"> <li>• the kidney is less likely to be rejected (1)</li> <li>• {tissues / cells / blood} will match / have {same / similar} {genes /DNA / antigens} (1)</li> <li>• because tissues / cells will not cause an immune response (1)</li> <li>• the donor can live (well) with only one kidney (1)</li> </ul>	<p>accept the kidney will be a suitable match</p> <p>accept: the donated kidney will be healthy / will remove urea without losing other substances (1)</p>	(2) A02.1

Q13.

Question number	Answer	Mark
	<p>A comparison including two from</p> <ul style="list-style-type: none"> <li>• both have some protein in their urine (1)</li> <li>• person A has less protein in their urine (than person B) (1)</li> <li>• amount of protein in the urine from person A is roughly the same / varies between 2 and 5 (arb units) / increases and then decreases (slightly) (1)</li> <li>• amount of protein in the urine from person B increases (each year) / changes from 25 to 106 (arb units) (1)</li> </ul>	<p><b>(2)</b> AO3.1a/3.1b</p>

Q14.

Question number	Answer	Additional guidance	Mark
(i)	<p>Substitution <math>110 \div 2.0^2</math> (1)</p> <p>Evaluation = 27.5</p>	<p>accept 28</p> <p>Award full marks for correct answer with no working.</p>	<p><b>(2)</b> AO1.2</p>

Question number	Answer	Mark
(ii)	<p>A description that includes <b>two</b> from:</p> <ul style="list-style-type: none"> <li>• lose weight (1)</li> <li>• control diet / eat less sugary food (1)</li> <li>• exercise <b>more</b> (1)</li> </ul>	<p><b>(2)</b> AO1.1</p>



Q15.

Question Number	Answer	Additional guidance	Mark
(i)	Any <b>two</b> from: <ul style="list-style-type: none"><li>• age (1)</li><li>• diet (1)</li><li>• exercise regime (1)</li><li>• ethnicity (1)</li><li>• genetic makeup (1)</li></ul>	accept other valid factors	(2) <b>AO3.3b</b>

Question Number	Answer	Additional guidance	Mark
(ii)	their high BMI is due to a high % of muscle (instead of fat)	accept their waist to hip ratio is low	(1) <b>AO3.3ab</b>

Q16.

Question Number	Answer	Additional guidance	Mark
(i)	<p>A description including:</p> <ul style="list-style-type: none"> <li>blood glucose concentration increased from {0 – 8 hours / from 100 to 139 / by 39 mg/dL} (1)</li> <li>then blood glucose concentration decreased [at 12 hours / to 90 mg/dL / by 49 mg/dL] (1)</li> <li>blood glucose concentration increased {at 20 hours / after 12 hours / to 134 mg/dL / by 44 mg/dL} (1)</li> </ul>	<p>accept blood glucose concentration increased {at 24 hours / to 137 mg/dL / by 47 mg/dL}</p> <p>accept other calculated increases between 12 and 24 hours</p>	<p>(3)</p> <p><b>AO3</b></p> <p><b>1 a + b</b></p>

Question Number	Answer	Additional guidance	Mark
(ii)	<p>An explanation linking:</p> <ul style="list-style-type: none"> <li>the pancreas produced insulin (1)</li> <li>but the cells in the {liver / muscles} were resistant to insulin (1)</li> <li>so glucose was not taken up by the {liver / muscles / cells} (1)</li> </ul>	<p>accept but there is insulin resistance</p> <p>accept so the glucose is not converted to glycogen in the {liver / muscles}</p>	<p>(3)</p> <p><b>AO2 1</b></p>



Question Number	Answer	Additional guidance	Mark
(iii)	<p>An explanation linking:</p> <ul style="list-style-type: none"> <li>the blood glucose concentration decreased (at 12 hours) (1)</li> <li>because the patient has used up the glucose in his blood (1)</li> <li>due to increased respiration (during exercise) (1)</li> </ul>	accept glucose used by {muscles / cells}	(3)  <b>AO3 2ab</b>

Q17.

Question Number	Answer	Additional guidance	Mark
(i)	<p>A description including:</p> <ul style="list-style-type: none"> <li>as the waist to hip ratio increases the probability of developing type 2 diabetes increases (1)</li> <li>accurate data from the results is used in the answer (1)</li> </ul>	<p>accept as one increases, the other increases</p> <p>ignore the columns get bigger</p>	(2)  <b>AO3.1ab</b>

Question Number	Answer	Additional guidance	Mark
(ii)	<p>evaluation</p> <ul style="list-style-type: none"> <li><math>(78.3 \div 90.0) = 0.87</math> (1)</li> </ul> <p>probability</p> <ul style="list-style-type: none"> <li>21(%)</li> </ul>	award full marks for correct answer no working	(2)  <b>AO2.1</b>

Q18.

Question number	Answer	Mark
	<p>An explanation that includes the following:</p> <ul style="list-style-type: none"> <li>• reduce the levels of carbohydrate / sugars / glucose in the diet (1)</li> <li>• to ensure that blood glucose levels do not rise too high / too quickly / so that the insulin can cope. (1)</li> </ul> <p>OR</p> <ul style="list-style-type: none"> <li>• lose weight (1)</li> <li>• insulin resistance reduced / body will produce more insulin / cells respond to insulin (1)</li> </ul>	<p><b>(2)</b></p> <p>AO 1 2</p>

Q19.

Question Number	Answer	Additional Guidance	Mark
	<p>An explanation linking:</p> <ul style="list-style-type: none"> <li>• blood glucose levels are not regulated / high (1)</li> <li>• because cells are resistant to insulin (1)</li> <li>• (so the liver) does not convert glucose to glycogen (1)</li> </ul>	<p>accept blood sugar levels</p> <p>accept there is insulin resistance / unresponsive to insulin reject immune</p> <p>accept hyperglycaemia / symptoms of hyperglycaemia (1)</p>	<p><b>(3)</b></p> <p><b>AO1</b></p>

Q20.

Question Number	Answer	Additional guidance	Mark
	<p style="text-align: center;">person <span style="float: right;">cause</span></p> <div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p>person A (type 1)</p> <p>person B (type 2)</p> </div> <div style="width: 50%;"> <ul style="list-style-type: none"> <li>• does not have a pancreas</li> <li>• cannot digest fatty foods</li> <li>• does not produce insulin</li> <li>• has cells that have stopped responding to insulin</li> <li>• cannot transport insulin in the blood</li> </ul> </div> </div> <p>Do not award mark if two lines are drawn from Person A (type1) box Do not award mark if two lines are drawn from person B (type 2) box</p>		(2) AO1.1

Q21.

Question number	Answer	Mark
	<p>Any <b>one</b> from:</p> <ul style="list-style-type: none"> <li>• (pancreas / body) {does not make insulin / makes very little insulin} (1)</li> <li>• {pancreatic /beta} cells are absent / destroyed (by immune system) (1)</li> <li>• (condition is) {inherited / genetic} / (can be) born with the condition (1)</li> </ul>	(1) AO 1 1

Q22.

Question number	Answer	Additional Guidance	Mark
	Any <b>two</b> from: <ul style="list-style-type: none"> <li>• gender (1)</li> <li>• age (1)</li> <li>• life style / exercise / diet (1)</li> <li>• size / weight / BMI (1)</li> </ul>	accept health (1)	(2) AO 2 2

Q23.

Question number	Answer	Additional guidance	Mark
(i)	An answer that combines points of interpretation/evaluation to provide a logical description: <ul style="list-style-type: none"> <li>• the internal temperature of the fish increases as the external temperature increases (1)</li> <li>• at a linear rate (1)</li> </ul>	Allow manipulation of figures from 2–34°C / correct reference to data	(2)

Question number	Answer	Mark
(ii)	An explanation that combines identification – knowledge (1 mark) and reasoning/justification – understanding (1 mark): <ul style="list-style-type: none"> <li>• otters need an optimum temperature of 37 °C as this is the optimum temperature for enzyme action (1)</li> </ul> Plus one point from: <ul style="list-style-type: none"> <li>• because at lower temperatures enzymes work too slowly (1)</li> <li>• because at higher temperatures enzymes are denatured (1)</li> </ul>	(2)

Q24.

Question number	Answer	Mark
(i)	As body temperature rises the oxygen consumption of the iguana is increased	(1) AO 3 1a

Question number	Answer	Mark
(ii)	An explanation linking the following: <ul style="list-style-type: none"> <li>• {chemical/enzyme/metabolic} reactions are increased at higher temperatures (1)</li> <li>• (more) respiration occurs (1)</li> <li>• (more respiration) requires oxygen (1)</li> </ul>	(3) AO 3 2a AO 3 2b

Question number	Answer	Mark
(iii)	An explanation linking the following: <ul style="list-style-type: none"> <li>• (panting) causes water loss (1)</li> <li>• causing evaporation / removal of <b>latent</b> heat (so reduction in temperature) (1)</li> </ul>	(2) AO 1 1

Q25.

Question number	Answer	Mark
	An explanation that combines identification – understanding (1 mark) and reasoning/justification – understanding (2 marks): <ul style="list-style-type: none"> <li>• shivering stops the body temperature falling when external temperature drops (1)</li> <li>• because increased muscle contraction (1)</li> <li>• generates heat via respiration/friction (1)</li> </ul>	(3)

Q26.

Question number	Answer	Mark
	<p>An explanation linking two from:</p> <ul style="list-style-type: none"> <li>• sweat/water is released onto the skin (1)</li> <li>• is evaporated (1)</li> <li>• transferring {thermal energy /heat} (1)</li> </ul>	<p>(2)</p> <p>AO1.1</p>

Q27.

Question number	Answer	Mark
(a)	C	(1)

Question number	Answer	Mark
(b)(i)	<p>An explanation that combines identification – understanding (1 mark) and reasoning/justification – understanding (2 marks):</p> <ul style="list-style-type: none"> <li>• ultrafiltration occurs in the glomerulus where the liquid part of the blood passes into the Bowman’s capsule (1)</li> <li>• reabsorption takes place as it travels through the proximal convoluted tubule into the loop of Henle (1)</li> <li>• finally urine production occurs in the collecting duct and excess fluid and sodium ions are removed (1)</li> </ul>	(3)

Question number	Answer	Mark
(b)(ii)	<p>An explanation that combines identification – application of knowledge (1 mark) and reasoning/justification – application of understanding (1 mark):</p> <ul style="list-style-type: none"> <li>• the kangaroo rat lives in the desert so it needs to retain as much water as possible (1)</li> <li>• as most water is reabsorbed in the loop of Henle, a longer loop gives more surface area for water reabsorption (1)</li> </ul>	(2)



Question Number	Indicative content	Mark
* (b)(iii)	<p>Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme.</p> <p>The indicative content below is not prescriptive and candidates are not required to include all the material that is indicated as relevant. Additional content included in the response must be scientific and relevant.</p> <p style="text-align: center;"><b>AO2 (6 marks)</b></p> <p>water content</p> <ul style="list-style-type: none"> <li>• increased ADH causes more water to be reabsorbed into the bloodstream</li> <li>• prevents dehydration</li> <li>• decreased concentrations of ADH cause less water reabsorption</li> <li>• greater volume of urine produced</li> <li>• at <math>0.0 \text{ mol/dm}^{-3}</math> of sodium ions the volume of ADH stored is at its highest</li> <li>• so the lowest amount of ADH is released</li> <li>• water levels in the body are regulated</li> </ul> <p>sodium ions</p> <ul style="list-style-type: none"> <li>• as sodium ion concentration increases the levels of ADH stored decrease</li> <li>• at <math>0.25 \text{ mol/dm}^{-3}</math> ADH stored reduced by 5 au</li> <li>• so a small amount of water is reabsorbed</li> <li>• at <math>0.50 \text{ mol/dm}^{-3}</math> ADH stored reduced by a further 30 au</li> <li>• a greater amount of water is reabsorbed</li> <li>• the volume of ADH stored remains stable at 8 au</li> <li>• causing the maximum amount of water to be reabsorbed</li> <li>• preventing dehydration when sodium levels are high</li> </ul>	<b>(6)</b>

Level	Mark	Descriptor
	0	No awardable content
Level 1	1-2	<ul style="list-style-type: none"> <li>• The explanation attempts to link and apply knowledge and understanding of scientific ideas, flawed or simplistic connections made between elements in the context of the question.</li> <li>• Lines of reasoning are unsupported or unclear. (AO2)</li> </ul>
Level 2	3-4	<ul style="list-style-type: none"> <li>• The explanation is mostly supported through linkage and application of knowledge and understanding of scientific ideas, some logical connections made between elements in the context of the question.</li> <li>• Lines of reasoning mostly supported through the application of relevant evidence. (AO2)</li> </ul>
Level 3	5-6	<ul style="list-style-type: none"> <li>• The explanation is supported throughout by linkage and application of knowledge and understanding of scientific ideas, logical connections made between elements in the context of the question.</li> <li>• Lines of reasoning are supported by sustained application of relevant evidence. (AO2)</li> </ul>

Q28.

Question number	Answer	Additional guidance	Mark
	<p>An explanation linking</p> <ul style="list-style-type: none"> <li>(internal) temperature is kept at the {<b>optimum</b>/best/37°C} (1)</li> <li>for enzyme action / (chemical ) reactions to take place (1)</li> </ul>	accept at high temperatures enzymes will denature (2)	(2)  AO1 1

Q29.

Question number	Answer	Mark
(i)	<p>D hypothalamus</p> <p>The only correct answer is <b>D</b> hypothalamus</p> <p>A is incorrect because the cerebral hemispheres do not control body temperature.</p> <p>B is incorrect because the medulla oblongata does not control body temperature</p> <p>C is incorrect because the cerebellum does not control body temperature</p>	(1) AO1.1



Question number	<i>Indicative content</i>	Mark
(ii)	<p style="text-align: center;"><b>AO2.1 (6 marks)</b></p> <p><b>How skin structures respond during hot weather</b></p> <p>Gland</p> <ul style="list-style-type: none"> <li>• sweat glands</li> <li>• produce sweat</li> </ul> <p>Hair / muscle</p> <ul style="list-style-type: none"> <li>• (erector) muscle will relax</li> <li>• hairs will 'lie down'</li> </ul> <p>Capillary</p> <ul style="list-style-type: none"> <li>• capillary (loop) allows more blood to flow through it</li> </ul> <p>Nerve (endings)</p> <ul style="list-style-type: none"> <li>• detect heat</li> <li>• send nerve impulses to the brain / CNS / hypothalamus.</li> </ul> <p><b>How responses help to reduce body temperature</b></p> <p>Sweat</p> <ul style="list-style-type: none"> <li>• sweat will spread out onto the surface of the skin</li> <li>• sweat / water will evaporate</li> <li>• using heat from the body</li> </ul> <p>Hair</p> <ul style="list-style-type: none"> <li>• less air will be trapped</li> <li>• air is an insulator</li> <li>• so less insulation</li> <li>• so more heat lost from skin</li> <li>• through convection</li> </ul> <p>Capillary</p> <ul style="list-style-type: none"> <li>• more blood flows closer to surface of the skin</li> <li>• so heat has less distance to travel until it leaves the body</li> <li>• so less insulation for heat to travel though</li> <li>• so more heat is lost through convection / radiation</li> </ul>	<b>(6)</b>

Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1-2	<ul style="list-style-type: none"> <li>• Demonstrates elements of biological understanding, some of which is inaccurate. Understanding of scientific ideas lacks detail</li> <li>• Presents an explanation with some structure and coherence</li> </ul>
Level 2	3-4	<ul style="list-style-type: none"> <li>• Demonstrates biological understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas is not fully detailed and fully developed.</li> <li>• Presents an explanation that has a structure which is mostly clear, coherent and logical.</li> </ul>
Level 3	5-6	<ul style="list-style-type: none"> <li>• Demonstrates accurate and relevant biological understanding throughout. Understanding of the scientific ideas is detailed and fully developed.</li> <li>• Presents an explanation that has a well-developed structure which is clear, coherent and logical.</li> </ul>

Level	Mark	Additional Guidance	General additional guidance
	0	No rewardable material	The level is determined by how skin structures react to hot weather The mark within the level is determined by the link between the responses of structures to heat is lost within each description.
Level 1	1-2	<ul style="list-style-type: none"> <li>• A simple description of a response of the skin to hot weather.</li> <li>• A simple explanation of how the response causes heat loss.</li> </ul>	<u>Possible candidate responses</u> <ul style="list-style-type: none"> <li>• Sweat is produced from the gland.</li> <li>• The sweat evaporates.</li> </ul>
Level 2	3-4	<ul style="list-style-type: none"> <li>• A description of the way at least one structures respond to hot weather</li> <li>• An explanation of how this response causes heat loss.</li> </ul>	<u>Possible candidate responses</u> <ul style="list-style-type: none"> <li>• The muscle relaxes letting the hair lie flat against the skin.</li> <li>• There is less air trapped so there is less insulation.</li> </ul>
Level 3	5-6	<ul style="list-style-type: none"> <li>• A detailed description of how more than one structures respond to hot weather.</li> <li>• A detailed explanation of how these responses cause heat loss.</li> </ul>	<u>Possible candidate responses</u> <ul style="list-style-type: none"> <li>• Sweat from the sweat glands spreads on to the skin surface. More blood flows through the capillary so the blood is nearer to the surface of the skin.</li> <li>• The sweat will evaporate taking the heat with it. The blood will be nearer to the surface of the skin so more heat will be lost by radiation.</li> </ul>

Q30.

Question number	Answer	Mark
	<p><b>C</b> hypothalamus</p> <p><b>The only correct answer is C</b></p> <p><i>A is not correct because the cerebellum does not control internal body temperature</i></p> <p><i>B is not correct because the medulla oblongata does not control internal body temperature</i></p> <p><i>D is not correct because the pituitary gland does not control internal body temperature</i></p>	<p><b>(1)</b></p> <p>AO1</p>

Q31.

Question number	Answer	Mark
(i)	<p>C hypothalamus</p> <p><b>1. The only correct answer is C</b></p> <p><i>A is not correct because the cerebellum is the main centre for balance not thermoregulation</i></p> <p><i>B is not correct because the cerebral cortex is the main area for higher thinking skills and logic not thermoregulation</i></p> <p><i>D is not correct because the pituitary gland releases hormones it is not the thermoregulatory centre</i></p>	<p><b>(1)</b></p> <p>AO 1 1</p>

Question number	Answer	Additional guidance	Mark
(ii)	<p>An explanation linking the following:</p> <ul style="list-style-type: none"> <li>• vasodilation acts to cool the body down (1)</li> <li>• more blood flows near the surface of the skin (1)</li> <li>• less blood flows through the shunt valve (1)</li> <li>• causing increased <b>thermal</b> energy loss (1)</li> </ul>	<p>accept capillaries widen near the surface of the skin. reject moving blood vessels.</p> <p>accept energy loss by <b>radiation</b></p>	<p><b>(4)</b></p> <p>AO 1 1</p>

## Q32.

Question number	Answer	Mark
(a)	<p>An explanation that combines identification – understanding (1 mark) and reasoning/justification – understanding (1 mark):</p> <ul style="list-style-type: none"> <li>• part A is the sweat (eccrine) gland which releases water on to the surface of the skin (1)</li> <li>• where heat is removed by evaporation (of the water) (1)</li> </ul>	<b>(2)</b>

Question number	Answer	Mark
(b)	C	<b>(1)</b>