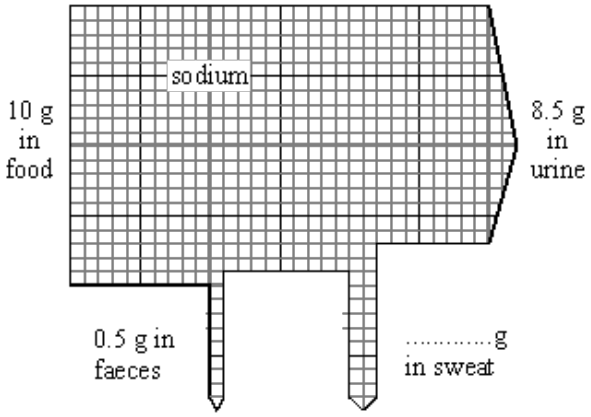
AQA B3.3 Homeostasis LEVEL 3

340 minutes

340 marks

Q1. To stay healthy, the amount of sodium in your body must not change very much.

On average, a girl takes in 10 grams of sodium a day in the food she eats.
The diagram shows what happens to this sodium.



(a) Add the missing figure to the diagram.

(1)

(b) The girl goes on holiday to a very hot place.
Her diet stays the same but she now loses 12g of sodium each day in sweat.

(i) How will this affect the amount of sodium she loses each day in her urine?

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(1)

(ii) What should the girl do to make sure that her body still contains enough sodium?

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(1)

(c) Usually, there is no glucose in urine. All of the glucose is re-absorbed from your kidney tubules back into your blood. Complete the following sentences to describe how this happens.

The glucose is re-absorbed by a process called .....

This process is needed because some of the glucose is re-absorbed against

.....

(2)
(Total 5 marks)

Q2. The figures below show the levels of carbon dioxide in air from 150 000 years ago.

TIME	CARBON DIOXIDE CONCENTRATION
1500 years ago	270 parts per million
1800 AD	290 parts per million
1957	315 parts per million
1983	340 parts per million

(a) Explain why carbon dioxide levels in the atmosphere are changing.

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(3)

(b) It is suggested that the increased level of carbon dioxide in the air is causing the atmosphere to warm up (the "Greenhouse Effect").

Describe, as fully as you can, **two** major effects of global warming and how these may affect the human population.

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(6)
(Total 9 marks)

Q3. Kidneys are important as they remove waste from blood and balance our water needs.

Kidney failure can be treated by transplant or dialysis using a kidney "machine".

The money for expensive treatment for a few people could be used to provide more patients with less expensive treatment for other complaints.

Dialysis – kidney "machines"
Most expensive
Need own machine or share machine in hospital
Restricted life – special diet, must return to machine
Can be used while patient waits for transplant

Kidney transplant
Very expensive but cheaper than dialysis
Need kidney from relative or from "newly" dead person
Independent
Transplant may be rejected

Discuss the advantages and disadvantages of using dialysis or kidney transplants to keep people alive.

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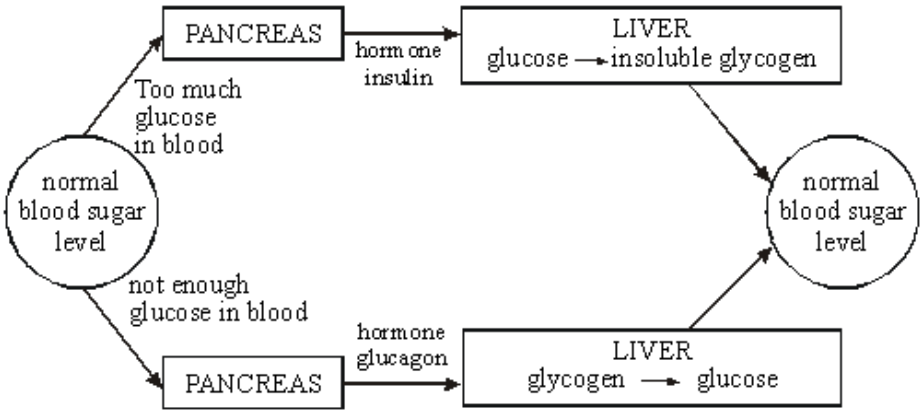
(Total 5 marks)

Q4.



The diagram shows how the blood sugar level is controlled in the body.

Explain fully what would happen if somebody ate some glucose tablets.

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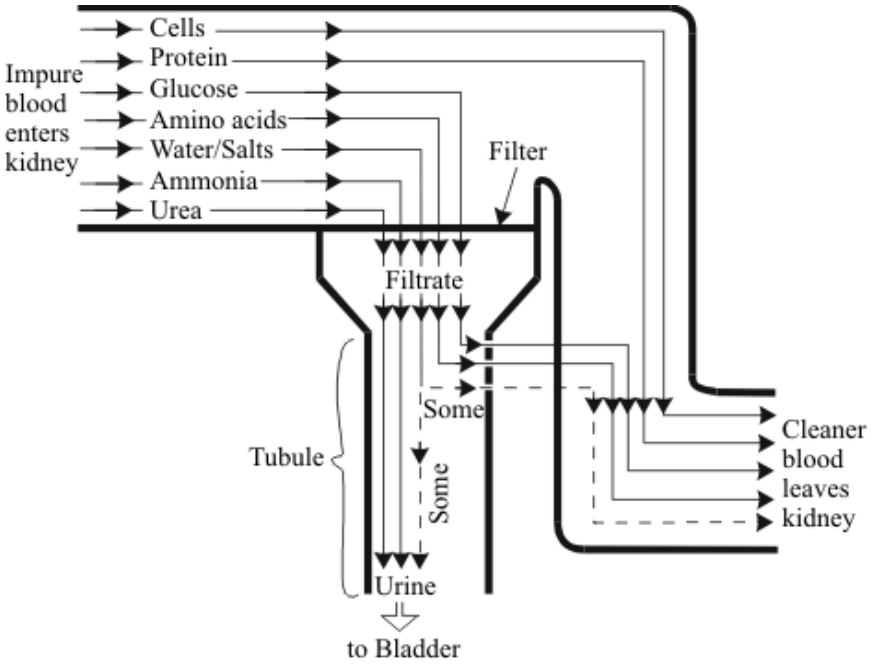
(Total 4 marks)

Q5. The job of our kidneys is to remove unwanted substances from our blood.

Substances which are needed in the blood must not be lost.

The flow-diagram below shows how the kidneys do this job.



(a) Describe what happens to the glucose and amino acids in the kidney.

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(4)

(b) A man has 5 litres of blood in his body.

In one day:
- the kidneys filter out 170 litres of liquid from the blood.
- he produces 1.5 litres of urine.

(i) What % of the filtered liquid is reabsorbed?

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(2)

(ii) The man became ill because his kidneys would not absorb as much of the filtered liquid.

Write down **two** ways the man would be affected by this.

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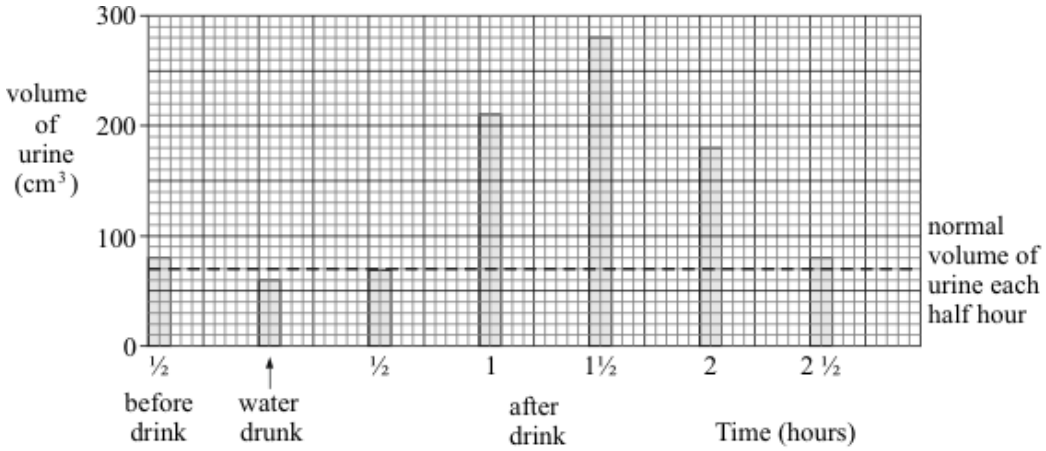
(2)

(c) In an experiment the man drank 800cm³ of water.

The diagram shows the effect this had on the volume of urine the man produced each 30 minutes.



Describe, in as much detail as you can, how drinking the water affected the volume of urine produced afterwards.

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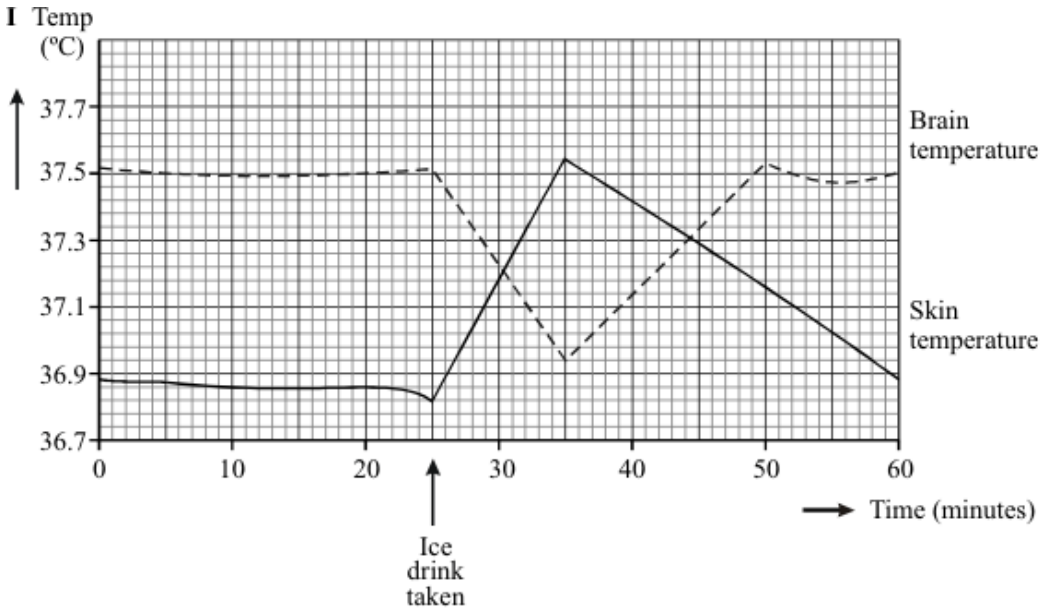
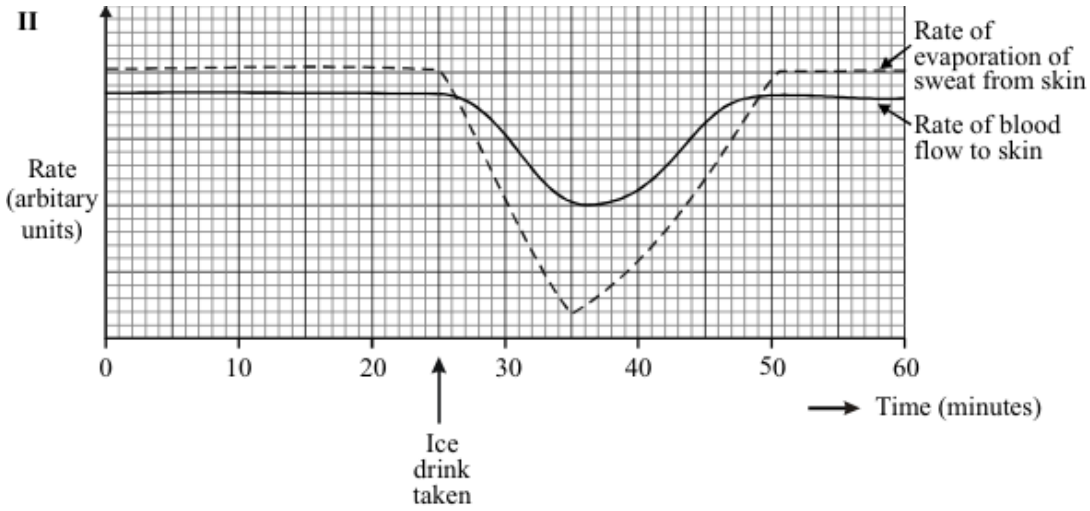
(5)
(Total 13 marks)

Q6. On a hot day, a student has an iced drink.

Graphs I and II show some of the changes to the student's body produced by the iced drink.





Use the information from the graphs to explain, as fully as you can, why the temperature of the student's skin rises after she has taken the iced drink.

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(Total 4 marks)

Q7. The table compares the percentages of various substances in a person's blood and their urine.

Substance	**Blood**	**Urine**
Water	92.00%	95.00%
Glucose	0.10%	0
Salt	0.37%	0.60%
Urea	0.03%	2.10%

(a) How does the level of urea in urine compare with the level of urea in the blood?

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(2)

(b) The kidney produces urine by filtering the liquid part of blood and then re-absorbing some of the filtered substances.

Use this information to explain the difference in the level of urea in urine compared to the level of urea in blood.

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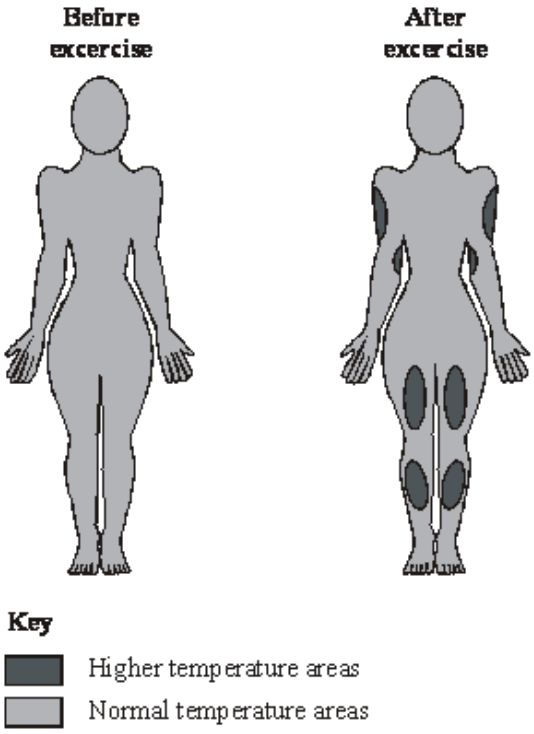
(2)
(Total 4 marks)

Q8. The temperature at the surface of the skin can be measured by using a technique called thermography.

In this technique, areas with higher temperature appear as a different colour on the thermographs.

The drawings below show the results of an investigation in which thermographs were taken from a person before and after exercise.



Describe and explain, as fully as you can, the effects of exercise on skin temperature.

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(Total 3 marks)

Q9. The table shows the amounts of some of the substances filtered, reabsorbed and excreted by the kidneys in one day.

Substance	Amount filtered	Amount reabsorbed	Percentage reabsorbed	Amount excreted
water		178.5 litres	99.2 %	1.5 litres
urea	56 g	28 g	50 %	28 g
glucose	800 units	800 units	100 %	0
sodium	25 200 units	25 050 units		150 units
chloride	18 000 units	17 850 units	99.2 %	150 units

(a) Calculate the amount of water filtered by the kidneys in one day.

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Amount ..... litres

(1)

(b) Calculate the percentage of the filtered sodium that was reabsorbed. Show clearly how you work out your answer.

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Percentage reabsorbed .....

(1)

(Total 2 marks)

Q10. (a) Explain how sweating helps to keep our body temperature relatively constant.

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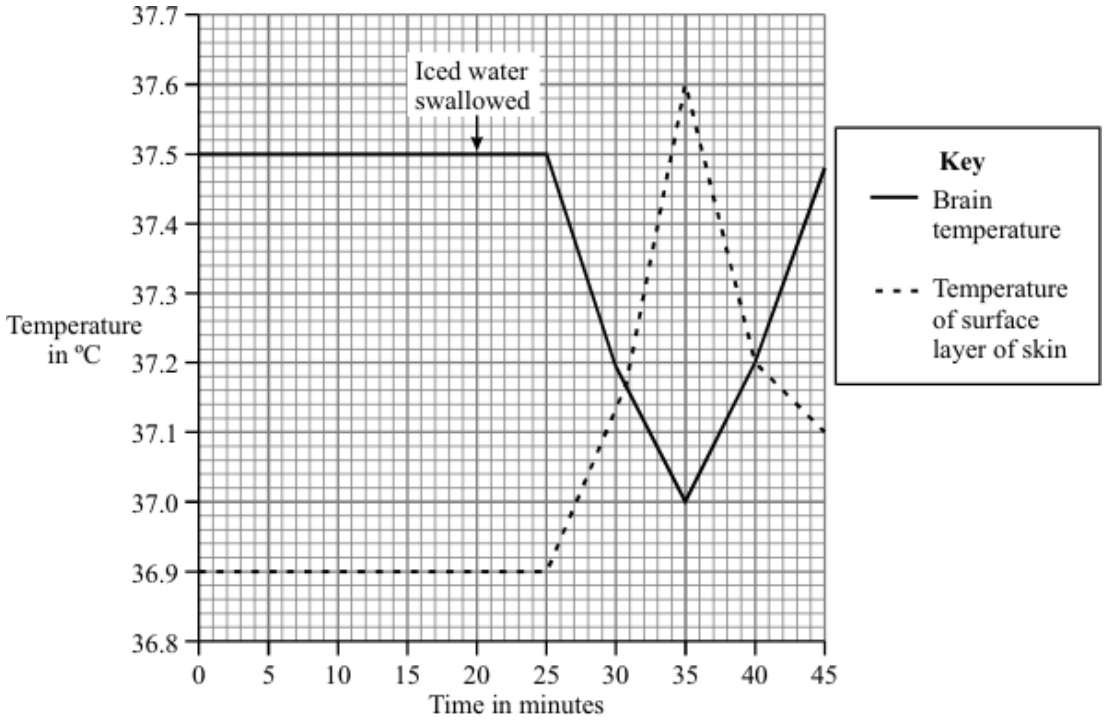
(2)

(b) In an experiment, a student swallowed some iced water. The graph shows how this affected the student's skin temperature and brain temperature.



(i) Explain why the temperature of the brain changed after the student swallowed the iced water.

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(2)

(ii) This change in brain temperature led to a change in the temperature of the surface layer of the skin.

Explain how this happened.

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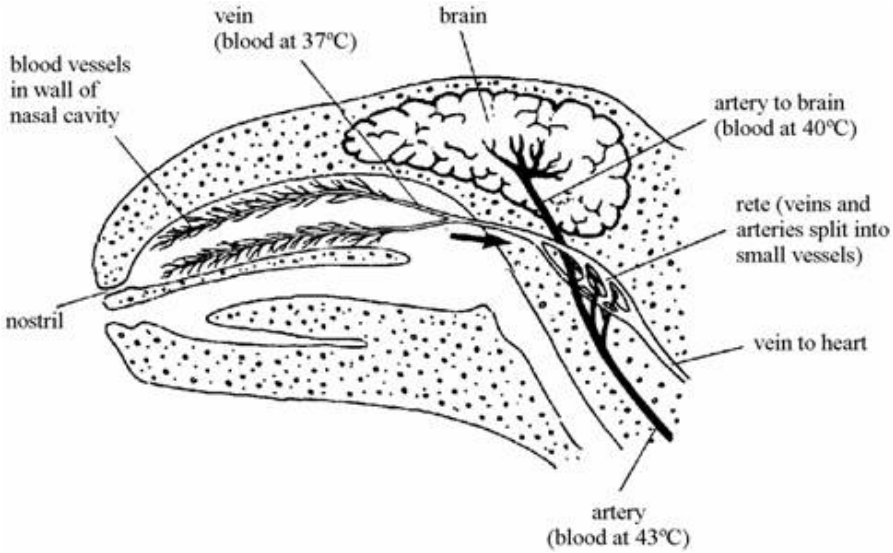
(3)
(Total 7 marks)

Q11. The gemsbok is a large herbivore that lives in herds in desert areas of South Africa. Gemsboks feed on plants that are adapted to living in dry conditions. There are not many rivers, lakes or ponds that can provide drinking water for the animals. The desert areas are hot during the day but cool at night. As the air cools at night it becomes moist, and the plants absorb the moisture.

Although the gemsbok lives in hot conditions, it does not sweat. During the day its body temperature can rise, but it is important that blood reaching the brain does not rise above 40°C. The drawing shows how the blood system is adapted to cool the blood which flows to the brain.



(i) Suggest an advantage to the gemsbok of **not** sweating.

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(1)

(ii) Explain how the blood is cooled in the cavities of the nose.

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(2)

(iii) How does the structure of the rete help in keeping the brain cool?

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(2)
(Total 5 marks)

Q12. (a) Explain, as fully as you can, why respiration has to take place more rapidly during exercise.

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(2)

(b) During exercise the process of respiration produces excess heat. Explain how the body prevents this heat from causing a rise in the core (deep) body temperature.

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(4)
(Total 6 marks)

Q13. The kidneys remove waste materials from the liquid part of the blood.

The table shows the concentration of certain substances

- in the liquid part of the blood
- in the liquid that has just been filtered from the blood in the kidneys
- in the solution in the bladder.

SUBSTANCE	CONCENTRATION (%)		
	IN LIQUID PART OF BLOOD	IN LIQUID THAT HAS BEEN FILTERED IN THE KIDNEYS	IN LIQUID IN THE BLADDER
Protein	7.0	0	0
Salt	0.35	0.35	0.5
Glucose	0.1	0.1	0
Urea	0.03	0.03	2.0

(a) (i) Which **one** of these substances does **not** pass into the liquid that is filtered in the kidneys?

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(1)

(ii) Suggest **one** reason why this substance does **not** pass out of the blood.

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(1)

(b) Explain why the concentration of urea in the liquid in the bladder is much greater than the concentration of urea in the liquid that is filtered in the kidneys.

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(1)

(c) (i) Describe how a kidney dialysis machine works.

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(3)

(ii) Use the data in the table to suggest the concentration that the salt in the dialysis fluid should be. Explain your answer.

Concentration .....

Explanation .....

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(2)
(Total 8 marks)

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Read the following passage which is from an advice book for diabetics.

Insulin Reactions

Hypoglycaemia or 'hypo' for short, occurs when there is too little sugar in the blood.
It is important always to carry some form of sugar with you and take it immediately you feel a 'hypo' start. A hypo may start because:

- you have taken too much insulin, or
- you are late for a meal, have missed a meal altogether, have eaten too little at a meal, or
- you have taken a lot more exercise than usual.

The remedy is to take some sugar.

An insulin reaction usually happens quickly and the symptoms vary – sweating, trembling, tingling of the lips, palpitations, hunger, pallor, blurring of the vision, slurring of speech, irritability, difficulty in concentration.

Do not wait to see if it will pass off, as an untreated 'hypo' could lead to unconsciousness.

(a) Many diabetics need to take insulin.

(i) Explain why.

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(2)

(ii) Explain why there is too little sugar in the blood if too much insulin is taken.

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(3)

(iii) Explain why there is too little sugar in the blood if the person exercises more than usual.

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(3)

(b) Suggest why sugar is recommended for a ‘hypo’, rather than a starchy food.

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(3)

(c) Explain how the body of a healthy person restores blood sugar level if the level drops too low.

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(3)

(d) Explain, using insulin as an example, what is meant by negative feedback.

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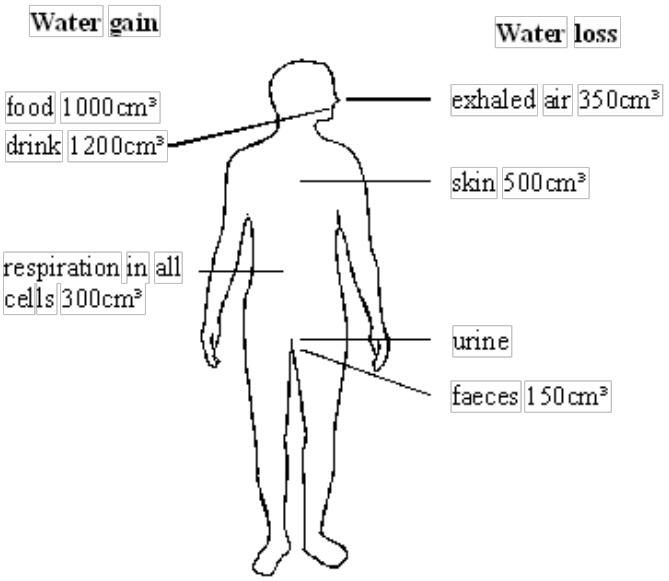
(3)
(Total 17 marks)

Q15. The diagram shows the mean daily input and output of water for an adult.



The kidneys keep the water content of the body constant by controlling the volume of water passed out in the urine.

(i) Use data from the diagram to calculate the mean daily output of water in urine. Show your working.

Answer ..... cm^3

(2)

(ii) Describe how the amount of water in the body is controlled by the kidneys.

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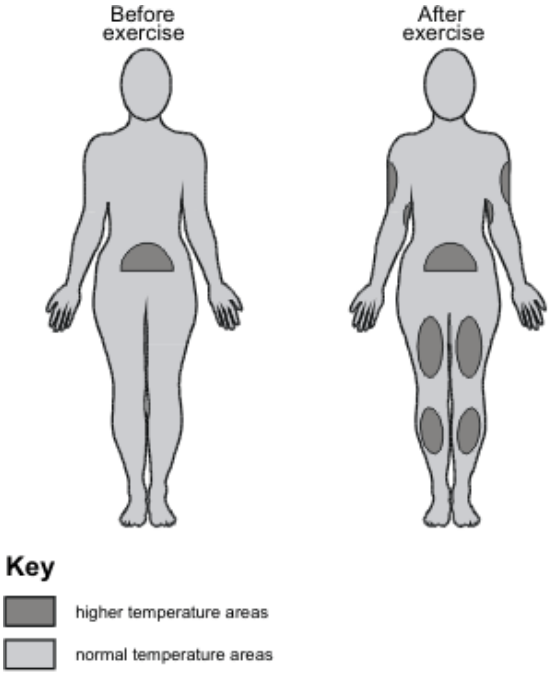
(3)

(Total 5 marks)

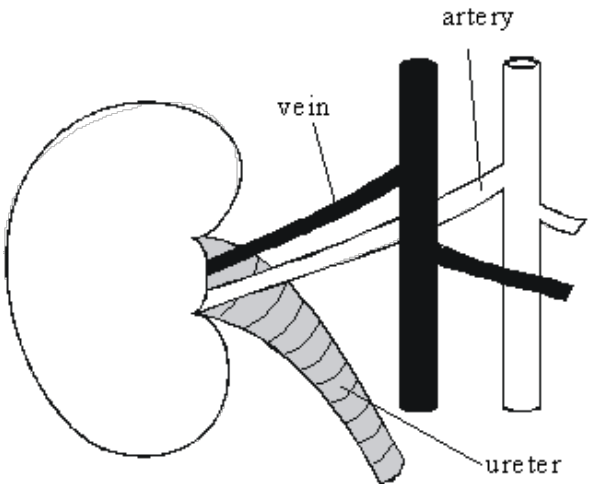
Q16. The temperature at the surface of the skin can be measured by using a technique called thermography. Areas with higher temperature appear as a light shade on the thermographs. The drawings below show the results of an investigation in which thermographs were taken before and after exercise.



Explain, as fully as you can, the body mechanisms which affected the skin temperature to give the results shown in the drawings.

(Total 8 marks)

Q17.



(a) The drawing shows a kidney, its blood supply and the ureter (a tube which carries urine from the kidney to the bladder). The amount and composition of the urine flowing down the ureter changes if the blood in the artery contains too much water. Describe these changes and explain how they take place.

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(4)

(b) (i) Describe, as fully as you can, **two** methods of treating patients who suffer from kidney failure.

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2. .....

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(4)

(ii) Compare the advantages and disadvantages of the two methods of treatment which you have described.

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(5)
(Total 13 marks)

Q18. (a) Describe, as fully as you can, the job of

(i) the circulatory system.

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(2)

(ii) the digestive system.

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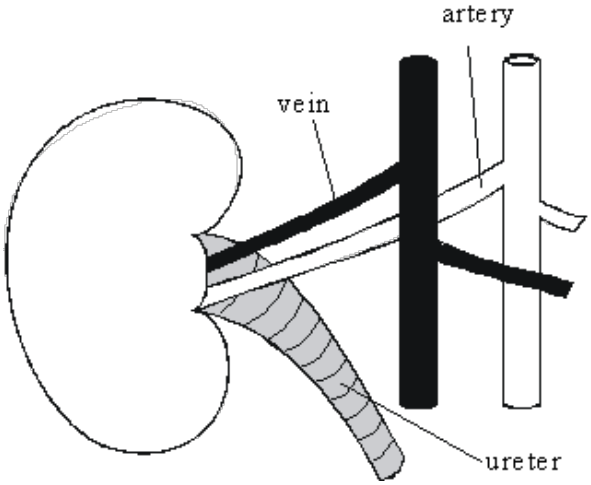
(3)

(b)



The drawing shows a kidney, its blood supply and the ureter (a tube which carries urine from the kidney to the bladder). The amount and composition of the urine flowing down the ureter change if the blood in the artery contains too much water. Describe these changes and explain how they take place.

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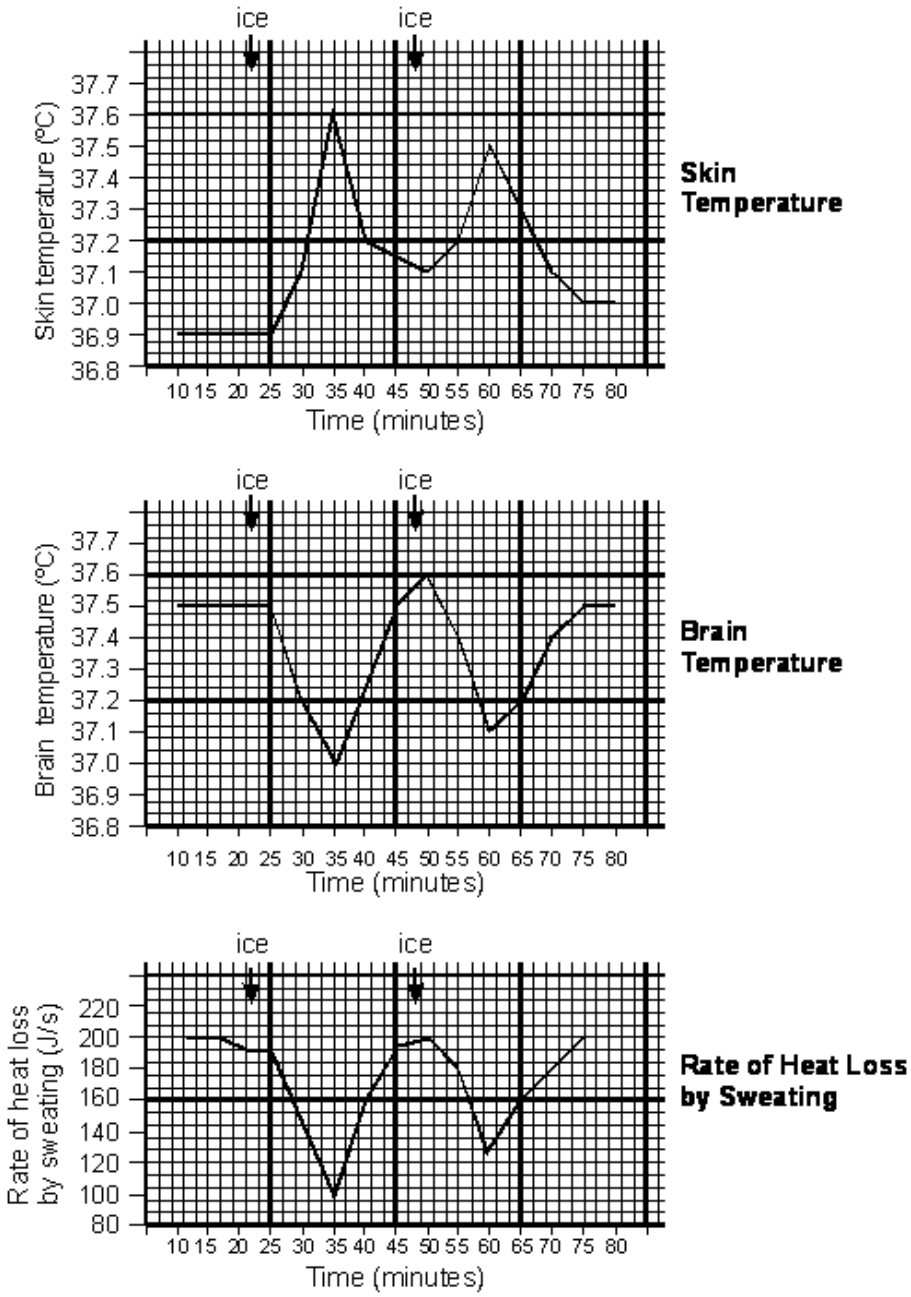
(4)
(Total 9 marks)

Q19. The graphs show the results of an investigation into the control of sweating in humans. The subject was placed in a chamber where the temperature was maintained at 45ºC. The subject swallowed ice at the times indicated on the graphs.



(a) What was the relationship between swallowing ice and the subject's

(i) skin temperature?

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(1)

(ii) brain temperature?

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(1)

(iii) rate of heat loss by sweating?

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(1)

(b) Explain, as fully as you can, why the subject's brain temperature, skin temperature and rate of heat loss by sweating were affected by swallowing ice in the way shown by the graphs.

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(8)
(Total 11 marks)

Q20.

Coordination of the body can be affected by chemicals called hormones

(a) (i) Where are hormones produced?

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(1)

(ii) How do hormones move around the body?

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(1)

(b) Insulin is a hormone.

(i) Where is insulin produced?

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(1)

(ii) Explain the role of insulin in controlling blood sugar levels.

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(4)
(Total 7 marks)

Q21. The pictures show three mammals and their average body temperature in ˚C.

Hamster

36.8 °C

Horse

38.0 °C

Sheep

39.2 °C

NOT TO SCALE

Describe **three** different ways by which most mammals are able to maintain a constant body temperature when the temperature of the environment falls.

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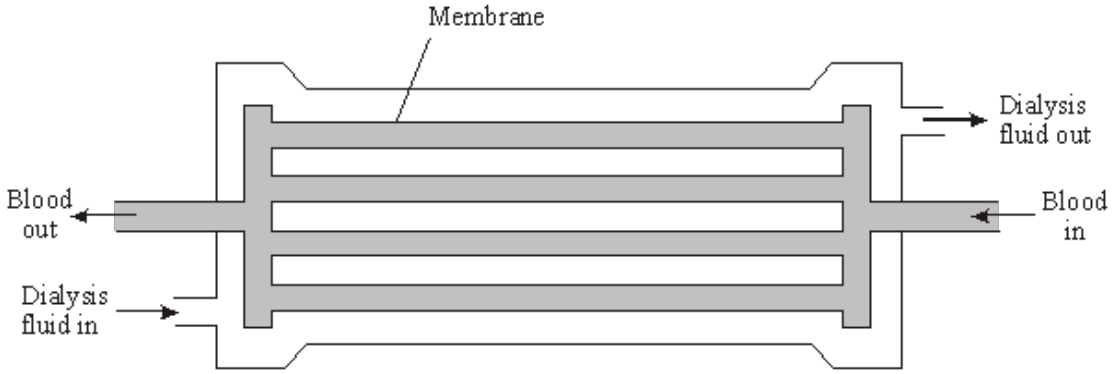
(Total 6 marks)

Q22. A woman suffers a minor infection that affects her kidneys. She is sent to hospital for treatment with a dialysis machine.

A simplified diagram of a dialysis machine is shown below.



(a) Explain why the membrane is important in the dialysis machine.

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(2)

(b) Some of the components of the woman's blood and of the dialysis fluid entering the machine are shown in the table.

Component	Woman's blood entering machine	Dialysis fluid entering machine
Blood cells	✓	✗
Glucose	✓	✓
Urea	✓	✗

Key: ✓ = present ✗ = absent

Use the information in the table to explain the composition of the dialysis fluid entering the machine.

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(4)

(c) One alternative to treatment with a dialysis machine is to have a kidney transplant.

Suggest why a kidney transplant might **not** be suitable in this woman's case.

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(2)

(d) Before dialysis treatment begins, the dialysis machine must be filled with blood. The woman has blood group **O**.

(i) What features of her blood make it group **O**?

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(2)

(ii) Why must the blood in the dialysis machine, before her treatment begins, also be blood group **O**?

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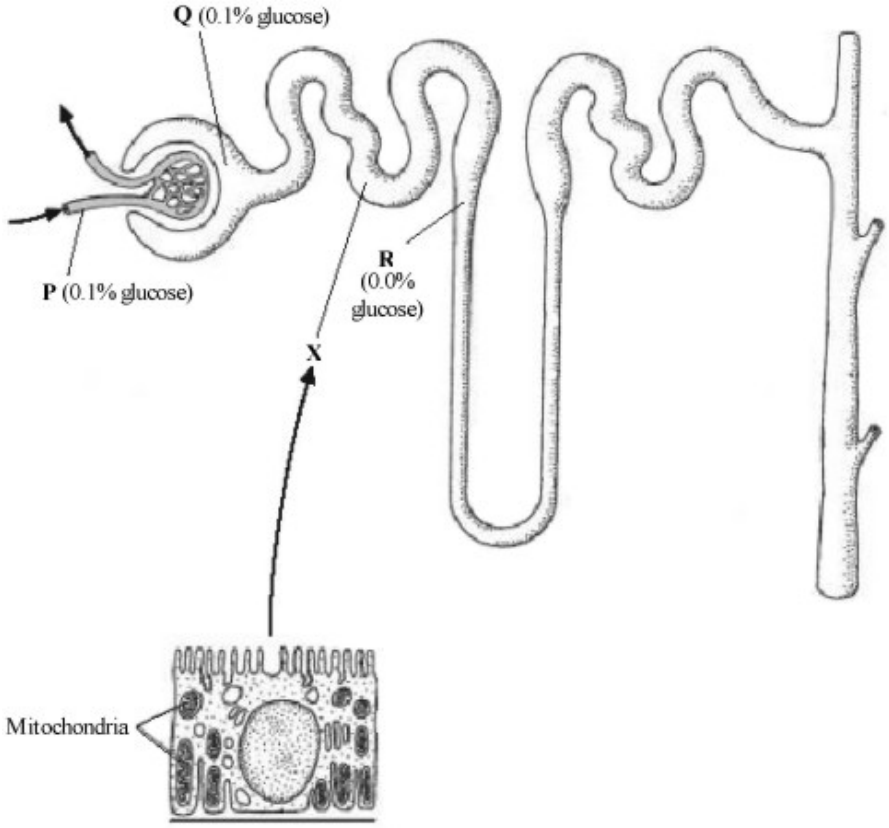
(1)

(Total 11 marks)

Q23. The diagram shows the structure of a kidney tubule.



Cell in wall of Region X.

All of these cells have
large numbers of mitochondria.

(a) Give the full name of the process which takes place in the mitochondria.

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(2)

(b) The concentration of glucose in the blood at **P**, and in the fluid at **Q**, is 0.1 per cent. The concentration of glucose in the fluid at **R** is 0.0 per cent.

Use information from the diagram, and your own biological knowledge, to explain the change in glucose concentration from point **P** through to point **R**.

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(5)
(Total 7 marks)

Q24. (a) Each day, a boy ate food containing 12 000 kilojoules of energy. The boy's body used 80 per cent of this energy to maintain his core temperature.

(i) Name the process which releases energy from food.

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(1)

(ii) Calculate the amount of energy that the boy would use each day to maintain his core body temperature. Show clearly how you work out your final answer.

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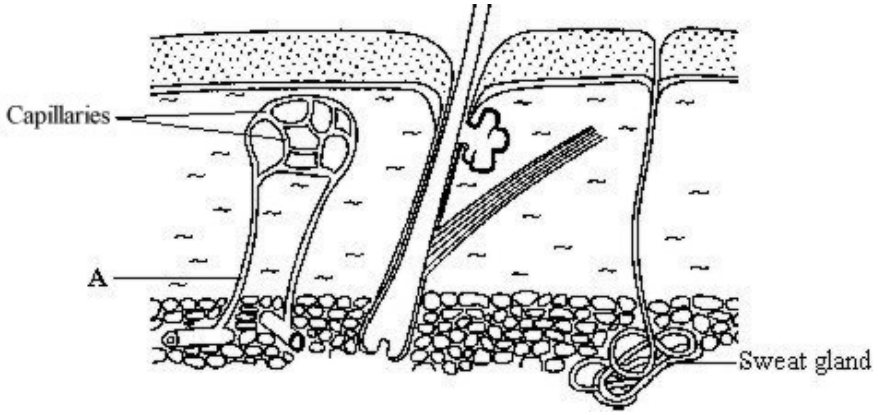
Amount of energy used each day = ... kJ

(2)

(b) The diagram shows a section through human skin.



Explain how structure **A** helps to cool the body on a hot day.

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(3)

(c) Body temperature is monitored and controlled by the thermoregulatory centre. Where in the body is the thermoregulatory centre?

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(1)
(Total 7 marks)

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The table shows the concentrations of some substances in human blood plasma, in the filtrate produced by the kidney and in the urine.

	Concentration in grams per dm^3		
Substance	**Blood plasma**	**Filtrate**	**Urine**
Glucose	1.0	1.0	0.0
Amino acids	0.5	0.5	0.0
Urea	0.3	0.3	20.0
Protein	80.0	0.0	0.0
Ions	7.2	7.2	15.0
Water	912.0	990.0	970.0

(a) Explain why:

(i) the concentration of glucose in the filtrate is the same as in the blood plasma;

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(1)

(ii) there is no glucose present in the urine.

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(1)

(b) Suggest why there is no protein present in either the filtrate or the urine.

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(1)

(c) The volume of water removed in the urine is variable. Explain how the human body reduces the volume of urine produced when less water is consumed.

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(3)
(Total 6 marks)

Q26. The table shows the concentrations of some substances in one person's blood plasma, kidney filtrate and urine.

Substance	Concentration in grams per dm^3		
	Plasma	**Filtrate**	**Urine**
Water	900.0	900.0	950.0
Protein	78.0	0.0	0.0
Glucose	0.8	0.8	0.0
Amino acids	0.4	0.4	0.0
Urea	0.3	0.3	20.0
Sodium ions	2.8	2.8	3.5

(a) (i) Protein is **not** present in the filtrate.

Explain why.

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(1)

(ii) Glucose is filtered out of the blood by the kidney and is then completely reabsorbed back into the blood.

What is the evidence for this in the table?

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(2)

(iii) Glucose is reabsorbed into the blood by active transport.

Give **two** ways in which active transport differs from diffusion.

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2 .....

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(2)

(b) The concentration of urea is much higher in the urine than in the filtrate.

Explain what causes this.

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(1)
(Total 6 marks)

Q27. The hormone insulin is a protein. Insulin is produced in the pancreas and controls blood glucose concentration.

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

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(1)

(b) We now know that a lack of the hormone insulin causes diabetes. In the early twentieth century there was no known cure for diabetes.

Frederick Banting and Charles Best carried out a number of experiments on dogs.

In the first experiment they removed part of the pancreas from a healthy dog (dog **A**). They ground up the pancreas tissue and injected an extract into dog **B**, whose pancreas had been removed to make it diabetic. Dog **B**'s diabetes was **not** cured.

Banting thought that an enzyme produced in the pancreas of dog **A** had digested the hormone before it was injected.

Name the enzyme that might have been responsible for digesting the hormone.

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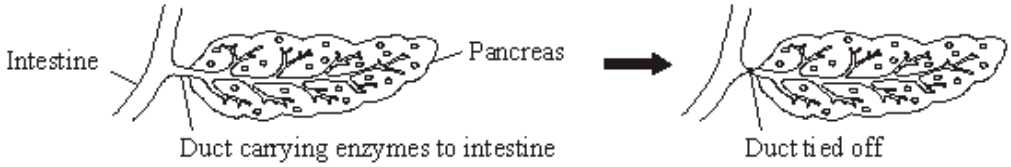
(1)

(c) In the second experiment with another healthy dog, Banting and Best tied off the duct which normally carries digestive enzymes out of the pancreas. This did **not** kill the dog.



(i) The dog survived even though enzymes from the pancreas could not digest food in the intestine.

Explain why the dog survived.

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(1)

(ii) As a result of these experiments, a method was developed to extract insulin from the pancreas.

Insulin is used to treat humans with diabetes.

The amount of insulin injected needs to be carefully controlled.

Explain why.

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(1)

(d) Evaluate the use of dogs in experiments of this type.

Remember to include a conclusion to your evaluation.

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(3)
(Total 7 marks)

Q28. (a) Why is glucose found in the blood but not in the urine? Use your knowledge of how the kidney works to explain your answer as fully as you can.

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(3)

(b) The table shows the concentrations of dissolved substances in the urine of a healthy person and the urine of a person with one type of kidney disease.

Substance	Concentration in grams per dm^3	
	Urine of healthy person	**Urine of person with kidney disease**
Protein	0	6
Glucose	0	0
Amino acids	0	0
Urea	21	21
Mineral ions	19	19

(i) Suggest an explanation for the difference in composition of the urine between the healthy person and the person with the kidney disease.

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(2)

(ii) The person with the kidney disease could be treated either by using a dialysis machine or by having a kidney transplant operation.

What are the advantages and disadvantages of having a kidney transplant operation rather than dialysis?

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(4)
(Total 9 marks)

Q29. The brain and the skin are involved in monitoring and controlling body temperature.

(a) Describe the parts played by the brain and the skin in monitoring body temperature.

(i) The brain

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(2)

(ii) The skin

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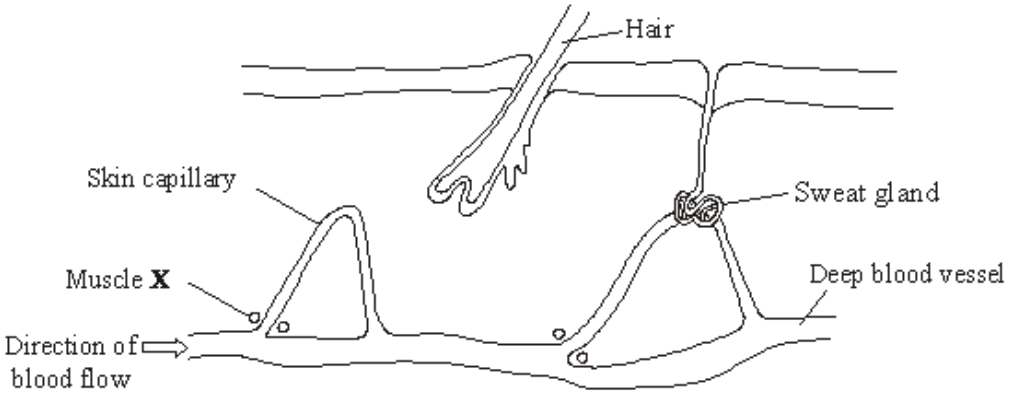
(1)

(b) The diagram shows a section through part of the skin.

The muscle labelled **X** controls the flow of blood into the skin capillary. When muscle **X** contracts, the flow of blood into the skin capillary is reduced.



Explain the role of muscle **X** in the control of body temperature.

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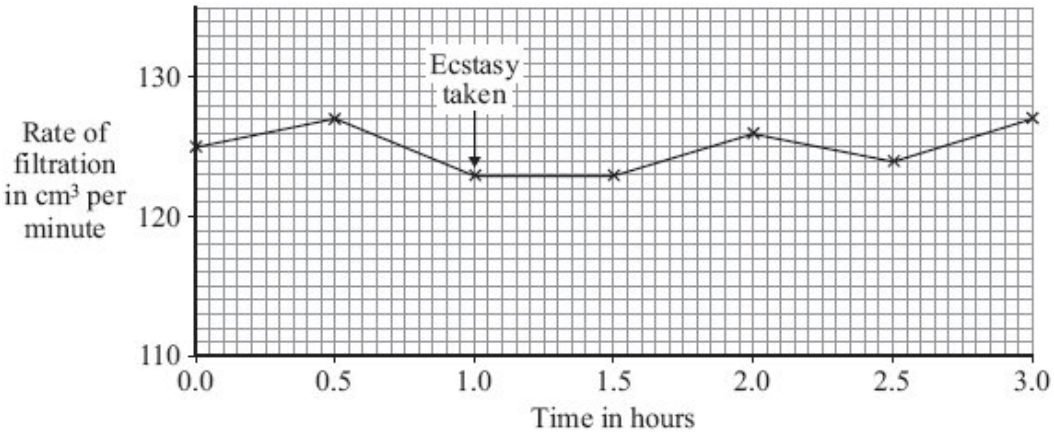
(3)
(Total 6 marks)

Q30. Taking the drug ecstasy affects the rate of urine flow from the kidneys.

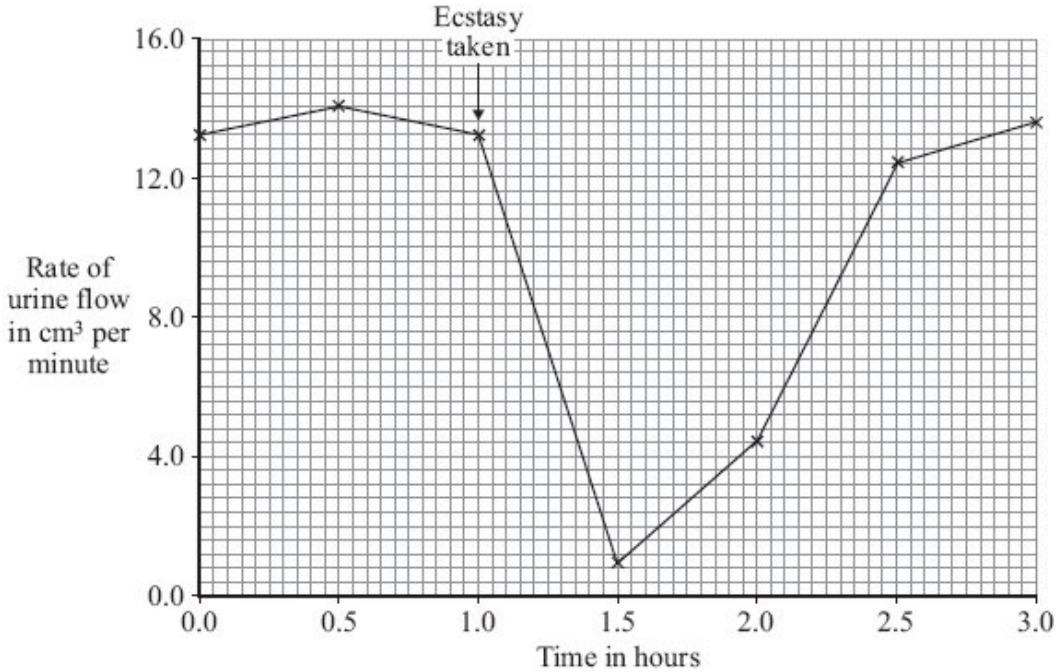
Graph 1 shows the rate of filtration by the kidneys of a healthy person.
Graph 2 shows the rate of urine flow from the kidneys of the same person.

One hour after the first measurement, the person took ecstasy.

Graph 1



Graph 2



(a) Describe the effect of taking ecstasy on

(i) the rate of filtration

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(1)

(ii) the rate of urine flow.

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(1)

(b) Use information from the graphs and your understanding of how the kidney works to answer the following questions.

(i) Suggest an explanation for the change in the rate of urine flow after the person took ecstasy.

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(2)

(ii) After a person has taken ecstasy, the concentration of ions in the blood changes.

Suggest an explanation for this.

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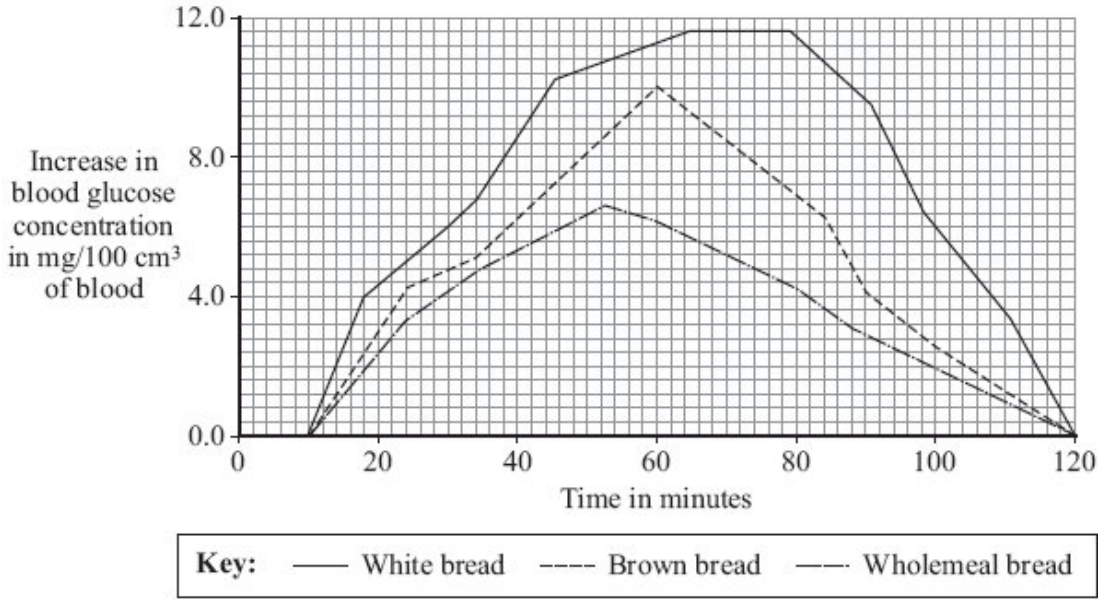
(2)
(Total 6 marks)

Q31. Insulin controls blood glucose concentration.

(a) The rate at which blood glucose concentration changes is affected by the food eaten.

In an experiment a person who does not have diabetes ate two slices of white bread. The change in her blood glucose concentration was recorded over the next 120 minutes. The experiment was repeated; first with two slices of brown bread and then with two slices of wholemeal bread.

The graph shows the results of the three experiments.



(i) Which type of bread would be most suitable for a person with diabetes?

Type of bread .....

Give **two** reasons for your answer.

1 .....

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2 .....

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(2)

(ii) Explain, as fully as you can, the reasons for the changes in blood glucose concentration when the person ate the brown bread.

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(4)

(b) *Pancreatic-cell transplantation* is a new treatment for diabetes. Insulin-making cells are taken from up to three dead donors. The cells are kept alive before being injected into the diabetic in a small operation. The cells soon begin to make insulin.

In one recent study 58 % of recipients of pancreatic-cell transplants no longer needed insulin injections.

Give the advantages and disadvantages of the new treatment for diabetes compared with using insulin injections.

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(3)
(Total 9 marks)

Q32. 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	1.0
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) Explain why protein is **not** found in the urine of a healthy person.

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(2)

(b) Substance **B** is **not** found in the urine of a healthy person.

Suggest an explanation for this.

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(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 can be found in the urine of a person with haemolytic anaemia.

Explain why.

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(3)
(Total 8 marks)

Q33. During exercise an athlete's core body temperature may rise.

(a) What causes this rise in core body temperature?

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(1)

(b) During a long race one athlete did not drink any liquid. Towards the end of the race the amount of sweat he produced began to fall.

(i) This athlete's core body temperature increased more than that of other similar athletes who had drunk enough liquid during the race.

Explain why.

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(2)

(ii) Describe **one** other way in which this athlete's body would respond in order to reduce core body temperature.

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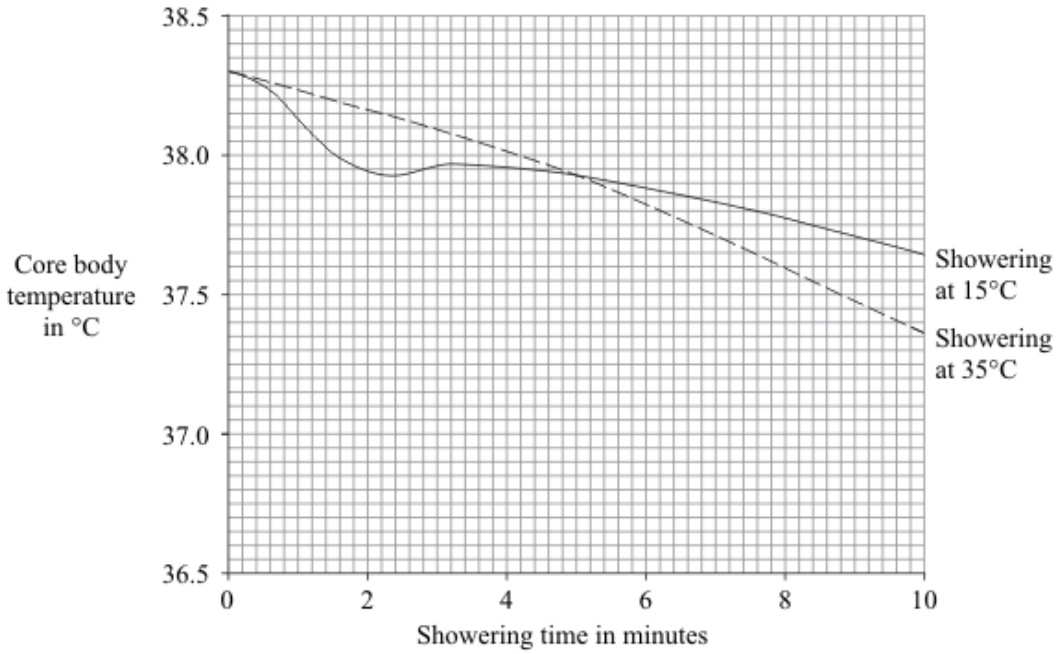
(2)

(c) The graph shows the effects of showering for ten minutes at 15 °C and at 35 °C on core body temperature after a long race.



Suggest an explanation for the differences in core body temperature:

(i) between 0 and 2 minutes

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(1)

(ii) between 4 and 10 minutes.

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(2)
(Total 8 marks)

Q34. The kidneys regulate the concentration of substances in the blood.

(a) Glucose is found in the blood but not in the urine.

Describe the processes that prevent glucose being excreted in the urine.

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(3)

(b) The table shows the concentrations of dissolved substances in the urine of a healthy person and the urine of a person with one type of kidney disease.

Substance	**Concentration in grams per dm^3**	
	Urine of a healthy person	**Urine of a person with kidney disease**
Protein	0	6
Glucose	0	0
Amino acids	0	0
Urea	21	21
Mineral ions	19	19

(i) Suggest an explanation for the difference in composition of the urine between the healthy person and the person with kidney disease.

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(2)

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

The person with the kidney disease could be treated either by using a dialysis machine or by a kidney transplant operation.

Compare the **advantages** and **disadvantages** of these two methods of treatment.

Use your knowledge and understanding of the two methods in your answer.

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(6)
(Total 11 marks)

Q35. The kidneys regulate the concentration of substances in the blood.

(a) Glucose is found in the blood but not in the urine.

Describe the processes that prevent glucose being excreted in the urine.

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(3)

(b) The table shows the concentrations of dissolved substances in the urine of a healthy person and the urine of a person with one type of kidney disease.

Substance	**Concentration in grams per dm^3**	
	Urine of a healthy person	**Urine of a person with kidney disease**
Protein	0	6
Glucose	0	0
Amino acids	0	0
Urea	21	21
Mineral ions	19	19

(i) Suggest an explanation for the difference in composition of the urine between the healthy person and the person with kidney disease.

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(2)

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

The person with the kidney disease could be treated either by using a dialysis machine or by a kidney transplant operation.

Compare the **advantages** and **disadvantages** of these two methods of treatment.

Use your knowledge and understanding of the two methods in your answer.

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(6)
(Total 11 marks)