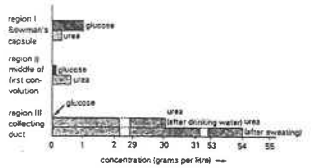
Past HKCEE Questions
Excretion and Osmoregulation
Paper I

1. The chart below shows the concentrations of glucose and urea in the fluid inside the following regions of a mammalian kidney:

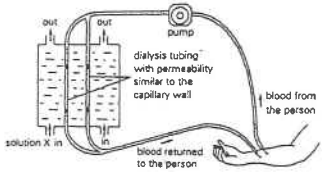
   I. the Bowman's capsule,
   II. the middle of the first convolution (coiled portion) of a kidney tubule, and
   III. the collecting duct.



   (i) State the changes in the glucose concentration as the fluid flows through the three regions.
   (ii) State and explain the changes in the urea concentration with reference to the flow of fluid along the kidney tubule.
   (iii) Compare and explain the differences in the urea concentration after drinking water and after sweating.
   (iv) Under what circumstances might glucose appear in the urine? Explain fully.

(HKCEE 1983)

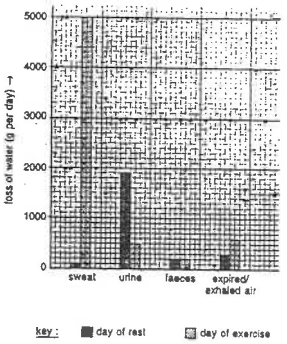
2. The diagram below shows how a person's blood is treated when his kidneys cannot function properly in removing urea. Solution X which is fed into the machine contains glucose and mineral salts at the same concentration as normal plasma.



   (i) State and explain the change in the urea concentration in the blood after treatment.
   (ii) Why is it necessary for solution X to have the same concentration of glucose and mineral salts as normal plasma?
   (iii) What is the advantage of passing solution X in a direction opposite to that of the blood?
   (iv) What would be the effect of allowing the blood to flow through a greater number of dialysis tubes? Give a reason for your answer.

(HKCEE 1984)

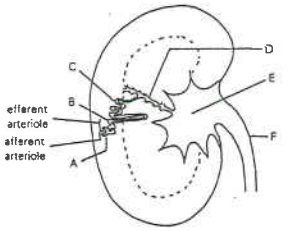
3. A person was confined to the same environmental conditions and was given a similar diet for two days. He rested completely on one day and performed exercises on the other. The weight of water lost from the different parts of his body in each day is shown in the chart below:



   (i) State any two environmental conditions that should be kept constant during these two days.
   (ii) Name the part of the body which produces
      (1) sweat.
      (2) urine.
   (iii) What is the total weight of water lost from the body
      (1) on the day of rest?
      (2) on the day of exercise?
   (iv) On the day of exercise, what is the advantage of producing
      (1) more sweat?
      (2) less urine?
   (v) Explain why the amount of water lost in the faeces was the same for these two days.
   (vi) Suggest a simple way to show that expired air contains water vapour.

(10 marks)
(HKCEE 1985)

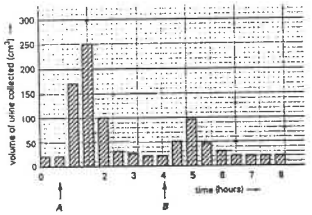
4. The diagram below shows the longitudinal section of a mammalian kidney and one of its nephrons.



   (i) Name the fluids in A and F. (2 marks)
   (ii) B and C are highly coiled. Explain the significance of this. (2 marks)
   (iii) State the process resulting in:
      (1) the absence of protein in A.
      (2) the absence of glucose in D. (2 marks)
   (iv) Compare and explain the concentration of urea in A and E. (2 marks)
   (v) State and explain the change in concentration of the fluid in F if a large amount of water is taken in by the mammal. (2 marks)
   (vi) Compare and explain the amount of glucose in blood entering and leaving the kidneys. (2 marks)

(HKCEE 1987)

5.
   (i) Distinguish between 'excretion' and 'egestion'. (2 marks)
   (ii)
      (1) Name TWO excretory substances that are produced by the human body.
      (2) For each substance named in (1), state where it is formed, and by which process it is formed. (6 marks)
   (iii) A healthy man drank two glasses of distilled water at time A and two more at time B. The chart below shows the volume of urine collected at half-hour intervals when the man tried to empty his bladder. The same environmental conditions were maintained throughout the whole period.



      (1) Explain why the volume of urine produced was greatly increased after drinking water at time A. (2 marks)
      (2) Suggest a reason to explain why the man's response to drinking water at time B was different from that at time A. (2 marks)
      (3) Urine is still formed by the body even when there is no water intake for a long time (e.g. 12 hours). Why? (2 marks)

(HKCEE 1988)

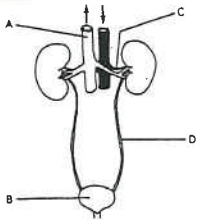
6. Two species of rats (A and B) live iii different habitats. Equal numbers of rats selected from each of the species were used in an experiment to investigate certain aspects of their osmoregulatory control. The rats selected were of similar mass and age. They were kept under the same environmental conditions and fed with the same amount of food - but no water. The results were as follows:

	Species A	Species B
Water gain from metabolism (arbitrary units)	81	80
Water loss by evaporation (arbitrary units)	90	168
Water content in faeces (% by weight)	2	20

   (i) State which species of rat lives in a drier habitat. Give ONE reason to support your answer. (3 marks)
   (ii) Suggest a type of metabolic activity through which the rats can gain water. (1 mark)
   (iii) Give TWO ways in which the rats may lose water by evaporation. (2 marks)
   (iv) Name the part of the alimentary canal responsible for regulating the water content in rat faeces. (1 mark)
   (v) If the experiment were conducted for a long period of time, which group of rats (species A or B) would die off first? Explain your answer. (3 marks)

(HKCEE 1989)

7. The diagram below shows the human urinary system:



Key: arrows indicate the direction of blood flow

(i) Name structures A and B. Give ONE function for each. (4 marks)

(ii) The table below shows the concentration of certain components of two fluids (X and Y) collected from two different regions of the urinary system:

	Concentration ($g\ 100\ cm^{-3}$)	
	Fluid X	Fluid Y
Protein	0.0	8.0
Glucose	0.0	0.1
Urea	2.0	0.03

(1) Using the letters in the diagram, state the respective regions from which fluids X and Y were collected. (2 marks)

(2) Explain why fluids X and Y differ in their concentrations of:

(I) protein

(II) glucose

(III) urea (6 marks)

(HKCEE 1990)

8. An experiment was performed to study the effect of the removal of the liver on the blood urea concentration of a mammal. The blood urea concentration of this mammal was measured from 07:00 to 20:00 hours. The animal's liver was removed at 08:00 hours. The results were as follows:

Time of day (hours)	Blood urea concentration ($mg\ per\ 100\ cm^3$ blood)
07:00	7.0
08:00 (liver removed)	7.0
11:00	3.6
14:00	2.6
17:00	2.0
20:00	1.6

(i) Plot a graph to show how the blood urea concentration varies with time. (3 marks)

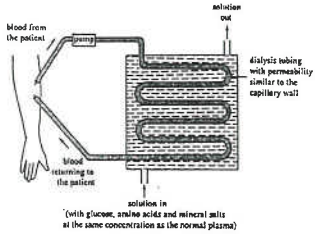
(ii) Explain the change in the blood urea concentration after 08:00 hours. (3 marks)

(iii) Describe and explain the changes in the blood urea concentration if the kidneys instead of the liver of the mammal were removed at 08:00 hours. (3 marks)

(iv) State ONE other function of the liver. (1 mark)

(HKCEE 1991)

9. Patients with kidney failure will die if they do not receive proper treatment. One method of treatment is to use a kidney machine. The diagram below shows the workings of a kidney machine:



(i) Urea is found in the solution passing out of the kidney machine. Account for this. (2 marks)

(ii) Give a reason for each of the following

(1) Each treatment takes a long time (about 6 hours). (1 mark)

(2) The treatment needs to be repeated at regular intervals (about 2-3 times a week). (1 mark)

(iii) Both the human kidney and the kidney machine are able to retain useful substances in the blood. Explain how this is achieved by

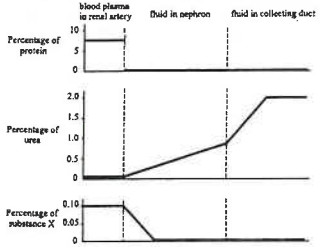
(1) the human kidney, (1 mark)

(2) the kidney machine. (2 marks)

(iv) Another method of treating kidney failure is to transplant a healthy kidney into the patient. Suggest two reasons why only a small number of such patients can receive this treatment in Hong Kong. (2 marks)

(HKCEE 1996)

10. The graphs below show the concentration of three substances in the renal artery, and the changes in their concentration along the nephron and the collecting duct:



(i) Explain the difference in the concentration of protein between the blood plasma and the fluid in the nephron. (2 marks)

(ii) What process causes the increase in urea concentration along the collecting duct? (1 mark)

(iii)

(1) What may substance X be? (1 mark)

(2) Explain the change in the concentration of substance X along the nephron. (3 marks)

(iv) If a person eats a lot of beans, how would the amount of urea excreted be affected? Explain your answer. (4 marks)

(HKCEE 2001)

11. A student carried out a study on the effect of two different sodium chloride solutions on red blood cells. He added a drop of citrated mammalian blood to 2 cm^3 of each solution in separate test tubes, A and B. After five minutes the mixtures in both tubes appeared light red in colour. He then examined 2 drop of each mixture under the microscope. After repeated examinations, he found that intact red blood cells were present in tube B only and they were in two different forms as shown below:

Wrinkled

Smooth

The results are recorded in the table below:

Tube	Concentration of solution (%)	Average number of different forms of intact red blood cells	
		Wrinkled	Smooth
A	0.3	0	0
B	1.5	15	5

Note: All observations were done under the same magnification.

(i) (1) In tube B, some red blood cells became wrinkled. How would you explain this? (3 marks)

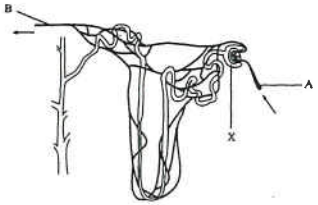
(2) Both forms of red blood cells were observed in tube B. Give reason for this. (1 mark)

(ii) How could the student be sure that the red blood cells in tube B had reached equilibrium with the surrounding solution at the time when he made the observation? (2 marks)

(iii) Account for the absence of intact red blood cells in the mixture in tube A and the light-red appearance of the mixture. (4 marks)

(HKCEE 2003)

12. The diagram below shows the structure of a nephron and its associated blood vessels:



Key: ⟵ direction of blood flow

(i) Name the fluid found in X. Explain how this fluid is formed. (4 marks)

(ii) Describe two ways in which glucose in vessel A may reach vessel B. Your answer should include the routes and the mechanisms involved. (4 marks)

(iii) Coffee contains a chemical called caffeine which causes dilation of vessel A. Explain how the presence of caffeine in the blood may increase the rate of urine production. (3 marks)

(HKCEE 2004)

13. The table below shows some information about the composition of the plasma, glomerular filtrate and urine of a healthy person:

Component	Content (g per 100 mL fluid)		
	Plasma	Glomerular filtrate	Urine
Water	90 – 93	97 – 99	96
Plasma proteins	7 – 9	0	0
Glucose	0.10	0.10	0.00
Chloride	0.37	0.37	0.60
Urea	0.03	0.03	2.00
Others	<1.0	<1.0	<2.0

(i)

(1) The following table shows the percentage change in chloride content of urine when compared with that of glomerular filtrate. Using the above information, complete the table by finding out the percentage change in urea content.

Component	Percentage change
Chloride	62.2 %
Urea	

(2) Give a reason for this change in the urea content. (1 mark)

(ii) Account for the difference in water content between the plasma and the glomerular filtrate. (3 marks)

(iii) A person suffers from diabetes and

glucose is detected in his urine. With reference to the cause of the disease, explain why his urine contains glucose.
(4 marks)

Past HKCEE Questions
Excretion and Osmoregulation
Paper II

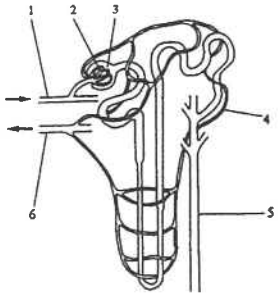
90- 39
Which of the following is NOT an excretory product?
A. urea
B. faeces
C. bile pigments
D. carbon dioxide

90-55
After drinking a lot of salty soup, a healthy person will produce

A. a small volume of urine with a high salt concentration.
B. a small volume of urine with a low salt concentration.
C. a large volume of urine with a high salt concentration.
D. a large volume of urine with a low salt concentration.

91
Directions: Questions 59 and 60 refer to the diagram below which shows the structure of a kidney tubule and is blood supply:

Key: → indicates direction of blood flow



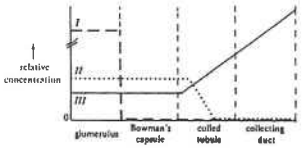
91-59
Which region has the highest blood pressure?
A. region 1
B. region 2
C. region 4
D. region 6

91-60.
In a healthy person, which of the following substances are found in region 1 but not in region 5?
(1) urea
(2) glucose
(3) proteins
(4) mineral salts

A. (1) and (2) only
B. (1) and (4) only
C. (2) and (3) only
D. (3) and (4) only

92-45
Urea is formed in
A. the liver.
B. the bladder.
C. the kidneys.
D. the sweat glands.

93-33
The graph below shows the relative concentration of glucose, proteins and urea in the fluids obtained from various parts of the mammalian kidney

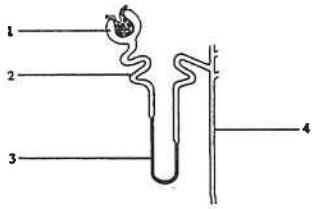


Which of the following correctly matches the three curves?

	I	*II*	*III*
A.	Proteins	urea	glucose
B.	glucose	urea	proteins
C.	proteins	glucose	urea
D.	glucose	proteins	urea

93-34
Which of the following is not an excretory organ of the human body?
A. the lung
B. the rectum
C. the liver
D. the kidney

94.
Directions: Questions 18 and 19 refer to the diagram below which shows the nephron of a mammalian kidney:



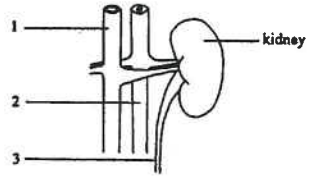
94-19
Which of the following correctly describes the processes occurring in different regions of the nephron?

	Region 1	Region 2	Region 4
A.	filtration	active transport	osmosis
B.	active transport	osmosis	filtration
C.	osmosis	active transport	filtration
D.	filtration	osmosis	active transport

94-20
Which of the following correctly indicates the changes in the amount of water lost from a man when the weather becomes drier and hotter?

	Amount of water lost from the skin	Amount of water lost from the kidneys
A.	increases	remains constant
B.	increases	decreases
C.	decreases	increases
D.	remains constant	decreases

95-34
The diagram below shows a kidney and some associated structures



The fluids in structures 1, 2 and 3 contain urea at different concentrations. Arrange them in descending order of ores concentration.
A. 1, 2, 3
B. 2, 3, 1
C. 3, 1, 2
D. 3, 2, 1

96-15
Which of the following is an excretory process?
A. exhalation
B. removal of undigested wastes
C. release of saliva
D. vomiting

99-35
The metabolic wastes excreted by a mammal include
(1) carbon dioxide.
(2) lactic acid.
(3) undigested food.
A. (1) only
B. (1) and (2) only
C. (2) and (3) only
D. (1), (2) and (3)

99-37
The salt concentration of the urine of a person was found to decrease shortly after he drank a glass of distilled water. Which of the following is a probable reason for this?
A. Less salt is excreted in the urine.
B. More water is excreted in the urine.
C. The water potential of the blood decreases.
D. Less salt is absorbed from the intestine into the blood.

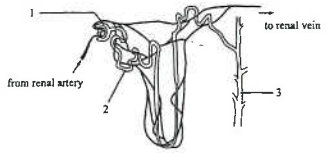
99-38
Compared to the blood in the renal artery, the glomerular filtrate in the Bowman's capsule has
A. a lower glucose concentration.
B. a higher urea concentration.
C. the same oxygen content.
D. less protein.

99-39
Which of the following descriptions of the air sacs of the lungs and the coiled tubules of the nephrons is correct?
A. Both have a rich blood supply.
B. Both have cells covered with cilia.
C. Both are freely permeable to dissolved substances.
D. Both have cells that carry out a high rate of respiration.

01-17
Which of the following are excretory wastes produced by the liver?
(1) urea
(2) bile salts
(3) carbon dioxide
A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

02- 8
Which of the following is not a normal component of the faeces of a healthy person?
A. urea
B. cells
C. bacteria
D. bile pigments

03.
Directions: Questions 37 to 39 refer to the diagram below, which shows the structure of a human nephron and its associated blood vessels:



03-37
At sites 1 and 2, there is movement of glucose between the blood and the fluid in the nephron. Which of the following correctly states the processes responsible for the movement of glucose at these two sites?

	Site 1	Site 2
A.	filtration	active transport
B.	diffusion	diffusion
C.	filtration	osmosis
D.	diffusion	active transport

03-38
In a healthy person, which of the following substances can be found in the blood of the renal vein?
(1) urea
(2) glucose
(3) mineral salts
A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

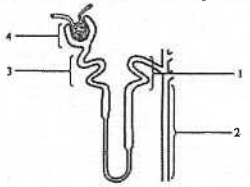
03-39
Which of the following correctly states and explains the change in concentration of the fluid in site 3 of a person after a basketball match?

	Change in fluid concentration	Reason
A.	decrease	a smaller proportion of water is reabsorbed
B.	decrease	less mineral salts are reabsorbed
C.	increase	a greater proportion of water is reabsorbed
D.	increase	more mineral salts are reabsorbed

04-33
Compared to the resting condition, when a person does vigorous exercise, there will be a great decrease in the amount of water lost through
A. exhalation.
B. sweating.
C. egestion.
D. urination.

05-28
Which of the following processes eliminates metabolic waste from the human body?
A. removal of trapped dust particles from the nasal cavity
B. passing out undigested food from the gut
C. breathing out air from the lungs
D. loss of heat from the skin

07
Directions:
Questions 49 and 50 refer to the diagram below, which shows the structure of a nephron.



07-49
Which region of the nephron has cells with the greatest number of mitochondria?
A. 1
B. 2
C. 3
D. 4

07-50
Which regions ate responsible for the reabsorption of water?
A. 1 and 2 only
B. 1 and 3 only
C. 2 and 3 only
D. 1, 2 and 3 only

Past HKCEE Questions
Excretion and Osmoregulation
Suggested Answers

Paper I

1. (i) decreases towards end of convolution 1
glucose disappears completely / zero concentration in collecting duct 1

(ii) increases continuously
owing to water reabsorption from tubule / active secretion of urea into the tubule (any ONE) 1

(iii)

	after drinking	after sweating	
conc. difference	lower	higher	either)
explanation	water in body increased by drinking	water in body decreased by sweating	either)
	reduced water reabsorp-tion from tubule	stimulate water reabsorp-tion from tubule	either)

(iv) when the person is suffering from diabetes 1
lack of insulin 1
without converting glucose into glycogen / without promoting uptake of glucose from blood by liver 1
blood glucose level remains high exceeding absorptive capacity of kidney tubule 1

2. (i) decrease 1
urea had diffused into solution X 1

(ii) to maintain normal concentration of plasma 1
by preventing net diffusion of glucose &/or salt 1

(iii) increase the efficiency of urea diffusion 1

(iv) by allowing greater area for diffusion 1
more urea will diffuse out / less time required 1

3. (i) temperature, relative humidity, wind, sunlight (any 2) 2

(ii) (1) sweat gland / skin
(2) nephron / kidney

(iii) (1) 2500g +/- 200 g 1
(2) 6300g +/- 200g

(iv) (1) more sweat produced would exert a greater cooling effect on the body 1
(2) less urine produced would compensate for the water loss through sweating / maintain the optimum water content in the body 1

(v) water reabsorption in the intestine &/OR water lost in faeces are not affected by exercise, sweating and urine output 1

(vi)

Method	Observation	
Breathing onto cold surface (e.g. mirror)	water droplets formed (misty)	any ONE 1 + 1
Breathing onto dry cobalt chloride paper	blue to pink	
Breathing onto anhydrous copper sulphate powder	white to blue	

4. (i) A - glomerular *filtrate 1
F - *urine 1

(ii) To increase surface area / time for more reabsorption 1 1

(iii) (1) ultrafiltration / filtration 1
(2) reabsorption / active transport 1

(iv) The urea concentration in E is higher than in A 1
due to water reabsorption 1

(v) the fluid in F becomes less concentrated 1
because a smaller proportion is being reabsorbed 1

(vi) amount of glucose in blood leaving the kidneys is smaller 1
because glucose is oxidised to provide energy 1

5. (i) Excretion - removal of metabolic waste from the body 1
Egestion - removal of undigested or unabsorbed food substances 1
(if candidates show no attempt to distinguish the two term - no marks)

(ii)

any TWO

	Substances	CO_2	Urea / Nitrogenous waste	Bile pigments	Water	1 + 1
(1)	Site of formation	body cells	liver	liver	body cells	1+1
(2)	process involved	cellular respiration	breakdown (deamination) of amino acids (proteins)	breakdown of RBC / haemoglobin	cellular respiration	1+1

(iii) (1) Blood / body fluid became diluted 1
A greater volume / proportion of water was excreted (a smaller proportion of water was reabsorbed) by the kidney 1
[Do not accept: less water was reabsorbed]

(2) he was probably doing some exercise 1
some water was lost as sweat 1

(3) urea / nitrogenous waste is constantly produced by the body 1
a high concentration of urea is toxic, need to be expelled as urine from the body 1

6. (i) Species A 1
because less water is lost by evaporation / water content in faeces is smaller 1
showing that species A has a better ability to conserve water / less likely to become dehydrated 1

(ii) oxidation of food / respiration 1

(iii) breathing 1
sweating 1

(iv) *large intestine / *colon 1

(v) group B would die off first 1
because both groups of rats gained similar amount of metabolic water 1
but group B has a poorer ability to conserve water / loses more water 1

7. (i) A - *vena cava 1
for transporting blood / wastes to the heart 1
B - urinary *bladder 1
for storage of urine 1

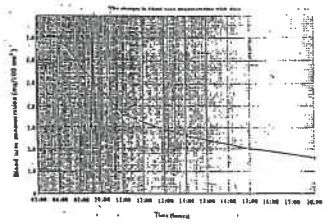
(ii) (1) X from B / D 1
Y from C (also accept A) 1

(2) (I) protein is present in Y but not in X because proteins are too too large to pass through the glomerulus / capillaries 1 1

(II) glucose is present in Y but not X because glucose passes into the nephron is reabsorbed from the glomerular filtrate 1 1

(III) the concentration of urea in X is higher than that in Y because urea passes into the nephron / urea in nephron is not reabsorbed 1
water is reabsorbed from the glomerular filtrate 1

8. (i)



correct choice of axes 1
coned labelling of axes with units 1
correct plotting of all points 1

(ii) At 08:00 hours, the liver was removed 1
no deamination to produce urea but 1
the kidneys continued to excrete urea in the urine. 1
Therefore the blood urea concentration decreased

(iii) increase in blood urea 1
as there is no kidney to excrete the urea 1
which is continuously formed by the liver 1

(iv) storage of blood / vitamin / iron / glycogen / formation of bile / regulation of blood sugar level, etc. 1

9. (i) Urea is present in the blood but not in the solution 1
It diffuses into the surrounding solution 1

(ii) (1) Because only a small volume of blood enters the kidney machine per unit time
OR 1
To allow time to remove most of the urea from the body

(2) Urea will be continuously produced by the body 1

(iii) (1) All useful substances in the glomerular filtrate are reabsorbed back into the blood along the kidney tubule 1

(2) As the solution contains the same concentration of glucose, amino acids and minerals as the normal plasma, 1
there is no net movement of these substances from the blood into the solution. 1

(iv) Not many people are willing to donate their kidneys after their death 1
The kidney transplanted must match with the tissue of the patient 1

10. (i) Proteins are present in the blood plasma but not in the fluid in the nephron . 1
because proteins are too large to pass through the wall of the glomerulus / Bowman's capsule 1

(ii) The reabsorption of water from the fluid as it passes along the collecting duct 1

(iii) (1) glucose / amino acids
(2) The concentration of substance X drops to zero along the nephron 1
because X is reabsorbed from the fluid into the capillaries 1
by active transport 1

(iv) The amount of urea excreted would increase 1
because beans contain a lot of protein 1
which is digested into amino acids / is absorbed in the form of amino acids 1
Excess amino acids are broken down in the liver forming urea
thus an increased amount of urea 1
will be excreted
Effective communication (C) 1

11. (i) (1) The water potential of the red blood cells was higher than that of the surrounding solution. 1
Water moved out of the cells. 1
As a result, the cells shrank and became wrinkled. 1
(2) Because the water potential of some red blood cells was higher than, while that of others was equal to / lower than the water potential of the surrounding solution. 1

(ii) Observe the red blood cells again after some time. 1
The proportion of the two forms should remain the same if they had reached equilibrium in the previous observation. 1

(iii) The water potential of the red blood cells was lower than that of the surrounding solution. 1
Water entered the cells. The red blood cells expanded and burst, releasing the haemoglobin to the solution, thus making it red. 1

12. (i) Glomerular filtrate 1
The high blood pressure in the glomerulus 1
forces some plasma / blood except some large proteins / 1
blood cells out of the glomerulus through the thin / porous wall of 1
the glomerulus and the Bowman's capsule into X.

(ii) Some glucose in the blood of vessel A are filtered into the Bowman's capsule. 1
At the first coiled tubule it is then reabsorbed 1
into the capillaries which drain back to vessel B. 1
Some glucose in vessel A is carried in blood flowing toward vessel B. 1

(iii) The flow rate of blood in vessel A is higher due to the dilation of the vessel. 1
The rate of formation of the glomerular filtrate will increase, 1
while the rate of water reabsorption in the kidney tubule 1
remains relatively the same, 1
thus the rate of urine production increases.

13. (i) (1) 6566.7% 1
(2) The urea content in urine is much higher because a large amount of water is reabsorbed / the amount of water reabsorbed along the kidney tubule is relatively much greater than that of urea 1

(ii) The water content of glomerular filtrate is greater than that of the plasma 1
because protein is too large to pass the wall of the glomerulus and that of the Bowman's capsule 1
The proportion of water in the glomerular filtrate thus increases 1

(iii) The person cannot produce sufficient insulin 1
to stimulate liver cells to convert glucose into glycogen 1
The level of glucose in the blood may become so high / exceed the threshold value 1
that glucose cannot be completely reabsorbed in the kidney 1
Thus it appears in the urine
Effective Communication (C) 1

Paper II

90-39	B
90-55	C
91-59	A
91-60	C
92-45	A
93-33	C
93-34	B
94-19	A
94-20	B
95-34	D
96-15	A
99-35	A
99-37	B
99-38	D
99-39	A
01-17	B
02-8	A
03-37	A
03-38	D
03-39	C
04-33	D
05-28	C
07-49	C
07-50	D