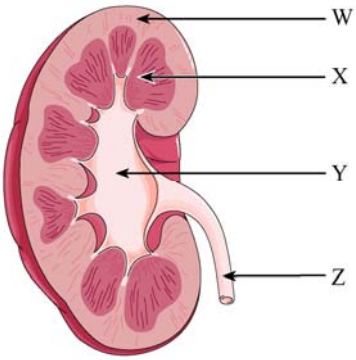
Excretory System

1.

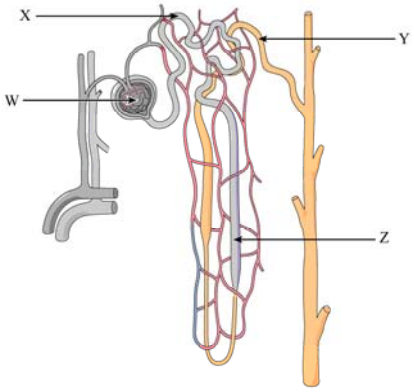


a)Label the parts indicated above and give one function for structures Y and Z

W- renal cortex -
X- renal medulla
Y- renal pelvis – collecting center of urine and then funnels it to ureter
Z- ureter – tube that transports urine from pelvis to urinary bladder

b) Which of the following is **not** a function of the organ shown?
A. to produce urea
B. to excrete metabolic wastes
C. to regulate the acidity of the blood
D. to maintain a constant blood volume

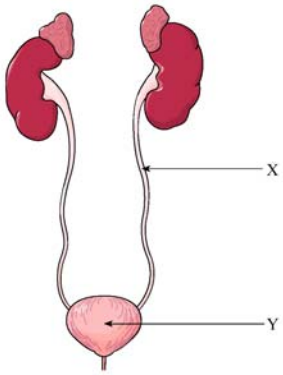
2.



The process that occurs at **W** is
A. tubular excretion.
B. pressure filtration.
C. reabsorption of water.
D. selective reabsorption.

The permeability of which structure is altered by secretions from the adrenal cortex?
A. W
B. X
C. Y
D. Z

3.

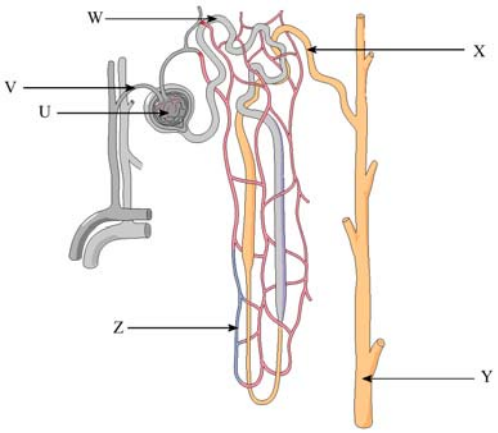


The structure labelled **X** is the
A. ureter.
B. urethra.
C. bladder.
D. collecting duct.

The function of the structure labelled **Y** is to
A. store urine.
B. filter blood.
C. produce urine.
D. maintain blood volume.

4. Demonstrate your understanding of negative feedback by describing how the kidneys and the hypothalamus work together to regulate blood volume (5 marks)
   - **Cells in the hypothalamus detect low water content in blood.**
   - **ADH is released into blood by hypothalamus, acting on distal tubule and collecting duct**
   - **Causes more water to be reabsorbed into the peritubular capillary.**
   - **Therefore, blood volume increases. As the blood becomes more dilute,**
   - **This is detected by the hypothalamus again, causing ADH secretion to stop.**

5. a) Identify the parts of the nephron in the following diagram.
   W- proximal convoluted tubule
   V- afferent arteriole
   U- glomeruls
   Z- descending loop of henle
   X- distal convoluted tubule
   Y- collecting duct



   b) Compare and contrast the composition of blood in V with Z (3 marks)

V	Z
More urea	**Less urea**
Same amount of nutrients	**Same amount of nutrients**
ontains RBC, plasma protein	**Does not contains RBC, plasma protein**
More salt	**Less salt**

   c) In a healthy person, the sequence of structures through which most glucose molecules pass is
   a) U, X, Y **b) U, W, Z** c) W, Z, X d) W, X, Y

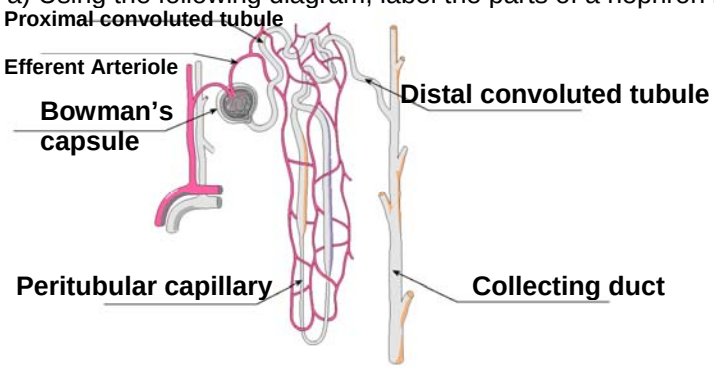
6. Plasma from a student was analyzed before and after a ten kilometer cross-country run. During the run, the student became dehydrated. Explain how the resulting lowered blood volume is detected by the body and describe a homeostatic mechanism by which it is returned to normal. **(6 marks)**
   - **Cells in the hypothalamus detect low water content in blood.**
   - **ADH is released into blood by hypothalamus,**
   - **ADH acts on distal tubule and collecting duct,**
   - **More water to be reabsorbed into the peritubular capillary.**
   - **Therefore, blood volume increases until the blood volume returned to normal. As the blood becomes more dilute,**
   - **This is detected by the hypothalamus again, causing ADH secretion to stop(negative feedback).**

7. Describe the process by which each of the following affects the composition of filtrate in the nephron (4 marks, 2 marks each) a) proximal tubule b) Loope of Henle

a) Selective filtration occurs here. Glucose, water, salts are reabsorbed into peritubular capillary network. In filtrate, concentration of nutrient and salts decrease, amount of water decreases,

b) **Reabsorption of water takes place here. Most of the water is reabsorbed by diffusion back to blood. In filtrate, amount of water decreases, sodium ions move out of loop, so the concentration of salts decreases.**

8. a) Using the following diagram, label the parts of a nephron in the blanks provided. **(3 marks)**



b) Identify **one** hormone that responds to a decrease in blood volume and explain how this hormone functions to return blood volume to normal levels. **(4 marks: 1 mark for name; 3 marks for explanation)**

see # 4 for solution

9. 8. Give **two** functions of each of the following urinary system structures. **(6 marks)**

a) Kidney

- **maintains the appropriate water-salt balance of the body**
- **the primary organ for excretion of nitrogenous wastes**

b) Collecting duct

- **collects filtrate and transfer filtrate to Ureter.**
- **site where hormone acts on, causing to reabsorb more water**

c) Proximal tubule

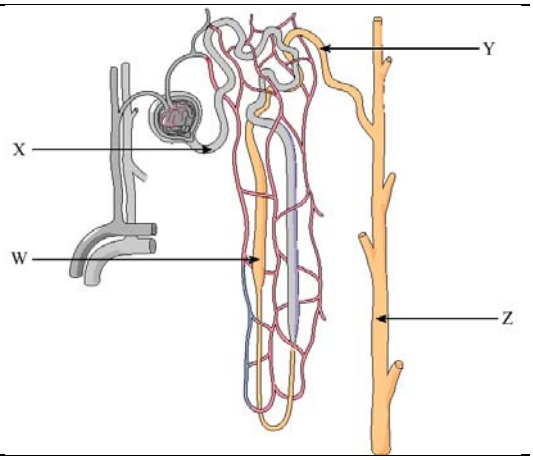
- **site of tubular reabsorption of little water and salts.**
- **Site reabsorption of nutrients into peritubular capillary.**
-

10. a) At which location would the greatest concentration of glucose be found?

A. W **B. X**
C. Y D. Z

b) The inability to regulate the concentration of sodium ions in the blood could be due to improper functioning of the

A. adrenal cortex, since it produces ADH.
B. adrenal cortex, since it produces aldosterone.
C. adrenal medulla, since it produces ADH.
D. adrenal medulla, since it produces aldosterone.



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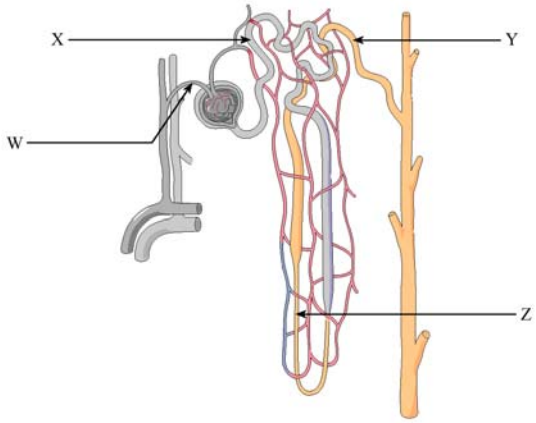


Identify the structures on the diagram and give a **different** function of each structure.
(8 marks: 1 mark each for name; 1 mark each for function)
X- Proximal tubule- site of selective filtration, glucoses are reabsorbed into blood.
W- Afferent arteriole – transport blood into glomerulus.
Y- Distal tubule- site where tubular secretion occurs. Non-filterable materials are added into filtrate.
Z- Peritubular capillary- exchange site where water is reabsorbed into.

12. Give **three** functions of the bicarbonate ion HCO_3 in the body and identify **one** specific location of each function. **(6 marks: 2 marks each)**

- **Control of pH in blood as a buffer through out the whole body. In blood, bicarbonate ions combine with hydrogen ions by reducing acidity of the blood.**
- **deliver of carbon dioxide, bicarbonate ions combines with $H^{+,}$ producing CO_2 and H_2O.**
- **in kidneys, control pH of blood, when the condition is too acidic, more HCO3- is reabsorbed to distal tubule; when the condition is too basic, less HCO3 – is reabsorbed into distal tubule , more will stay in blood, neutralizing the basic environment.**

13. The maintenance of optimum pH is essential to living systems. Give **three** different locations in the body where pH is regulated and explain how it is maintained.
(6 marks: 1 mark each for locations; 1 mark each for explanations)

- **In kidneys—nephrons vary the amount of H+, NH3 are excreted, and the amount of HCO3- and Na+ reabsorbed to distal convoluted.**
- **in lungs ---hemoglobin will act as buffers, binding CO2 is an indicator of acidity in lungs. If the level of CO2 is high, medulla oblongata detects and let person breathe out CO2.**
- **In blood vessels –HCO3- , Hb can combined with hemoglobin to reduce the acidity in blood as a means of reduced hemoglobin or plasma protein will be denatured.**

14. Describe the process by which each of the following affects the composition of filtrate in the nephron. **(4 marks: 2 marks each)**
a) Proximal Tubule- selective filtration- glucoses in the blood are reabsorbed into blood though efferent arteriole.
b) Loop of Henle- Reabsorption of water- water in the filtrate is re absorbed into peritubular capillary.

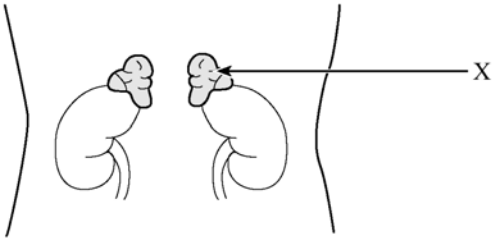
15. State **one** function of each of the following. (6 marks: 1 mark each)
i) Glomerulus: **squeeze small molecules out of blood to tubule as filtrate**
ii) Aldosterone: **a hormone, produced by adrenal cortex, causes more Reabsorption of sodium ions in order to raise blood volume.**
iii) Ureter: **a tube that transport urine from renal pelvis to the urinary bladder.**
iv) Distal convoluted tubule: **site of tubular secretion, absorb non- filterable substances, eg, drugs**
v) Urinary bladder: **an organ that stores urine**
vi) Peritubular capillary network: **functions in reabsorption during urine formation.**

16. a) List **two** substances that are selectively reabsorbed at the proximal convoluted tubule of a nephron. **1. glucose** **2. amino acids**

b) List **two** substances that are excreted at the distal convoluted tubule of a nephron.
1. drugs **2. hydrogen ions**

c) What effect does increased antidiuretic hormone (ADH) have on urine production? **(1 mark) ---amount of urine is less, concentration of salts increase .**

A 17. The structure identified by **X** in the diagram below is the
A. adrenal gland.
B. thyroid gland.
C. hypothalamus.
D. pituitary gland.



a) High concentrations of ADH (antidiuretic hormone) in the blood will result in
A. increased excretion of H_2O.
B. decreased pressure filtration.
C. decreased reabsorption of glucose.
D. increased solute concentration of the urine.

b) Which of the following describes the tissues surrounding the loop of Henle?
A. High H^+ concentration, high K^+ concentration.
B. Low water concentration, low salt concentration.
C. High salt concentration, low water concentration.
D. High water concentration, low K^+ concentration.

c) If the blood is excessively acidic, it will **likely** lead to urine
A. of increased pH.
B. of decreased pH.
C. with increased Na^+ concentration.
D. with decreased NH 3 concentration.

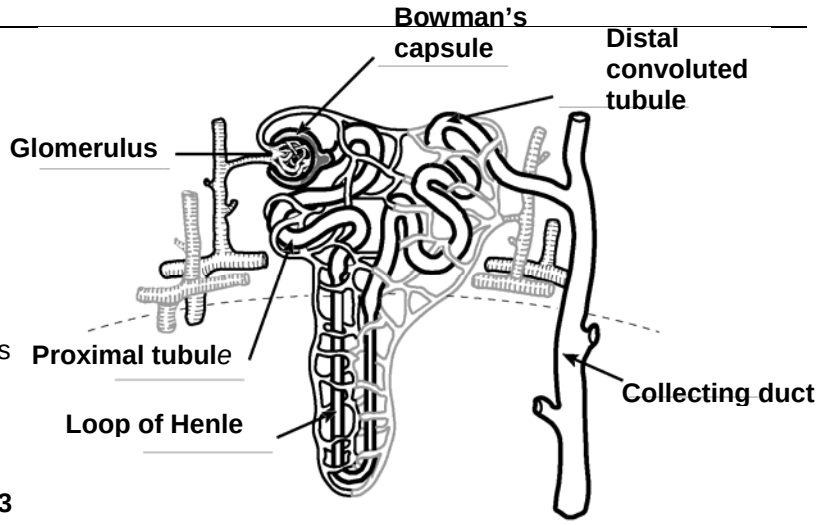
d) Which of the following symptoms might be an indication of kidney failure?
A. Salt in the urine. B. Urea in the urine.
C. Protein in the urine. D. Uric acid in the urine.

D 18.

The inner portion (labelled X) of the endocrine gland above secretes
A. insulin.
B. cortisol.
C. adrenalin.
D. aldosterone.

19. **Use the following list to answer the next question.**
Proximal tubule
Loop of Henle
Distal tubule
Bowman's capsule
Collecting duct
Glomerulus

a) Label the structures indicated on the following diagram using the terms given above.
(3 marks: ½ mark each)



b) Give **ONE** role of each of the following in the production of urine. **(3 marks: 1 mark each)**

i) Glomerulus: **site of pressure filtration, water, wastes, nutrients are squeezed out of blood into tubule.**
ii) Proximal tubule: **site of tubular reabsorption, nutrients and water are reabsorbed into blood.**

iii) Distal tubule: **site of tubular excretion, drugs , hydrogen ions, and creatinine are added into the tubule.**

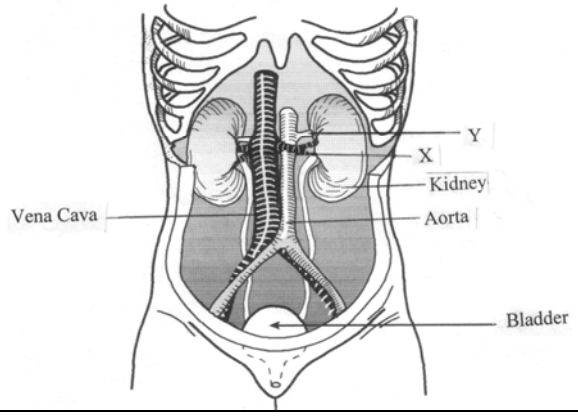
20. Describe the negative feedback system for aldosterone and how it regulates the constant salt concentration in blood and blood volume in body (8 marks)

- **low blood Na^+ concentrations, and low blood volume is detected by juxtaglomerular apparatus detects low blood volume, releasing renin**
- **renin in the blood converts Angiostensinogen –Converting enzyme in the pulmonary capillary.**
- **A-C enzyme converts angiostensin I to angiostensin II.**
- **A-II travels to adrenal gland, causing it to releasing aldosterone.**
- **Aldosterone acts on the nephrons in the kidneys, causing more sodium ions to be reabsorbed into blood.**
- **Therefore, more water is reabsorbed from the tissue, blood volume increases.**
- **As the blood volume increases, juxtaglomerular apparatus detects the increase of blood volume, stopping releasing renin.**

21. a) Name the parts X and Y in the diagram
X- renal vein
Y- renal artery

b) List three ways that the blood in vessel Y differs from the blood in vessel X
Y - lower concentration of urine
- more nutrients
--more oxygen

X - higher concentration of urine
-- less nutrients
-- less oxygen



22. The table shows the amounts of substances present in human blood plasma, tubular filtrate and urine. All are measured in grams per 100 cm^3 of fluid.

COMPONENT	PLASMA	FILTRATE	URINE
glucose	0.10	0.10	Nil
amino acids	1.05	1.05	Nil
proteins	8.00	0.01	0.01
inorganic salts	0.72	0.72	1.50
urea	0.03	0.03	2.00
uric acid	0.004	0.004	0.05

a) Account for the differences in the levels of proteins in the plasma and filtrate. (1 mark)
There are much more proteins in the plasma. Since proteins are too big to be squeezed into tubule during pressure filtration.
b) The concentration of inorganic salts in urine is approximately double that present in the filtrate. Explain this difference. (3 marks)

- **In filtrate, water is reabsorbed into peritubular capillary.**
- **Since the solute of salts do not change, the solvents decrease.**
- **Therefore, when urine is formed, the concentration of salts increases.**

23. Alcohol appears to inhibit the secretion of anti-diuretic hormone (ADH). Predict the results of alcohol intake on the following. Include in your answer a description of the mechanism responsible for the resulting concentration.
a) solute concentration of the blood plasma (3 marks)

- **alcohol reduces ADH production and ADH reduces the amount of urine produced**
- **∴ less water is reabsorbed into the blood because the amount of salts do not change.**
- **Therefore, the solute concentration of the blood plasma will increase.**

b) urine production (2 marks)

- **since there is no ADH acting on the collecting duct, less water is reabsorbed,**
- **more water stays in the tubule → becomes part of urine ∴ amount of urine will increase.**

24. Assume that a bacterial infection results in large perforations in the glomerulus and the Bowman's capsule of a patient.
a) How will the glomerular filtrate in the diseased person compare to the glomerular filtrate of a healthy person? (2 marks)

- **High pressure needed for pressure filtration will not exist therefore reduced pressure filtration (or not at all)**
- **Filtrate of the diseased person would ∴ have less water, wastes, nutrients and salts because these substance would not be forced out of the blood.**
  OR
- **If perforations are large enough then large molecules may move out by diffusion**
- **Filtrate may contain red blood cells and white blood cells as well**

b) What effect will this have on the level of antidiuretic hormone (ADH) circulating in the bloodstream? (1 mark)
Since the glomerular filtrate in the diseased person has less amount of water in the tubule due to the big hole, pituitary gland detects this low water content, so ADH is releasing. ADH level increases.
c) A person with this disease would experience swelling of the body tissues. Using your knowledge of kidney function and the blood tonicity, explain the mechanism that accounts for this swelling. (3 marks)

- **Swelling is caused by too much excessive water in the body tissue.**
- **Holes in the Glomerulus allows large molecules like RBC and plasma proteins leave the blood plasma and go into the filtrate.**
- **Function of plasma proteins is to maintain blood volume∴ less water brought back into the blood (osmosis) and water flows from blood to tissue.**

25. What effect will anti-diuretic hormone (ADH) not being produced in the hypothalamus have on the normal body functions in humans? (2 marks)
- **ADH controls reabsorption of water which acts on the distal tubule and collecting duct, regulating the blood volume and pressure in the body.**
- **If the ADH is not produced, the person produces more urine. However, lacking of ADH cause less water to be reabsorbed, this will cause the person to be dehydrated.**

26. Trace the flow of urine from the kidney to the outside of the body by listing the following structures in the correct order and state a function of each: urethra, ureter, urinary bladder. (2 marks each)
Ureter- tube that transport urine from renal pelvis to urinary bladder.
Urinary bladder- receives urine from Ureter to urethra, stores urine.
Urethra- the structure that carries out the urine from the body.

27.

SUBSTANCE	**CONCENTRATION IN PLASMA** g/100 mL	**CONCENTRATION IN FILTRATE** g/100 mL	**CONCENTRATION IN URINE** g/100 mL
a. **Glucose**	0.100	0.100	0.000
b. **Protein**	8.00	0.000	0.000
c. **Ammonia**	0.004	0.004	0.07

a) Account for the filtrate and urine concentrations in each of the above substances by stating the part of the nephron and the process or processes responsible for producing each of the concentration values. (9 mark)

- **Pressure filtration forces all glucose into the filtrate.**
- **At the proximal tubule reabsorption occurs and glucose is brought back into the blood**
- **Therfore no glucose in the urine.**

- **Proteins are big molecules**
- **Therefore cannot be forced out by pressure filtration**
- **Therefore all protein stays in blood and there is no proteins in filtrate and urine.**

- **Ammonia is forced into the filtrated by pressure filtration**
- **When the tubular excretion at the distal tubule brings in more ammonia is added into tubule**
- **Hence, there is the highest concentration of ammonia in the urine.**

b) Explain what could cause high levels of glucose in the urine. (2 marks)

1. **proximal tubule is broken, no glomerular reabsorption can not take place. No glucose is reabsorbed into blood, most go into tubule.**
2. **Diabetes—too many molecules in urine due to the lack of carrier proteins.**

28. Give one function for each of the following parts of the excretory system. (4 marks: 1 mark each)
a) Ureter—**the tube that comes from the renal pelvis to urinary bladder for transporting urine.**
b) glomerulus – **site of pressure filtration, squeezes smaller molecules out of blood into tubules**
c) distal tubule – **site of the tubular excretion that drugs, hydrogen ions, ammonia are added to the filtrate.**
d) bladder – **stores the urine before delivering though urethra.**
e) proximal tubule—**the site of tubular reabsorption where nutrients, little water, and salts are reabsorbed into the peritubular capillary.**

29. What are the three possible routes through the kidney of a glucose molecule after it enters the renal artery? (4 marks)
1. renal artery—Glomerulus—Bowman's capsule—proximal tubule—back to blood (reabsorbed)
2. renal artery—Glomerulus—Bowman's capsule—proximal tubule—(not get reabsorbed)loop of Henle—distal tubule ---collecting duct
3. renal artery---afferent arteriole---Glomerulus--- efferent arteriole
b) Which one of the routes through the kidney would a urea molecule NOT take? (1 mark)
A urea molecule may be reabsorbed in the collecting duct, so it would not take the 3rd one.
c) How does the kidney respond when the blood is too acidic? (4 marks)
- **When the blood is too acidic,**
- **more H+ , and NH4+ are reabsorbed into tubule, reduced acidity , more HCO3- are excreted, buffering H+. Also, Sodium bicarbonate ions can neutralize acids, to yield NaOH, strong base.**

30. Explain how aldosterone helps to maintain blood volume. Detail the steps associated with the release of aldosterone, as well as the feedback loop associated with the control of its release. (8 marks)

See # 20

31. The anterior pituitary gland has been called the "master gland." Justify this claim using two specific examples. (4 marks)
- **Hypothalamus produces ADH and ADH is then sent to the posterior pituitary gland**
- **Pituitary gland releases ADH which acts on the kidneys and causes them to reabsorb more water**

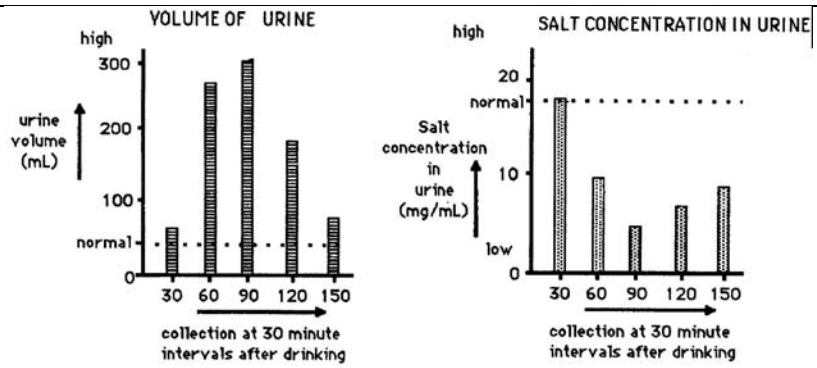
OTHER EXAMPLES NOT TESTABLE AT THIS TIME (see p. 401)

32. What effect will each of the following have on the quantity and the composition of urine? Give an explanation for each effect. (6 marks)
a) Low arterial blood pressure. (3 marks)
- **Low blood pressure will be detected by the hypothalamus.**
- **Hypothalamus releases ADH, acting on distal tubule and collecting duct**
- **More water will be reabsorbed in those two areas, less water in urine∴ urine will be more concentration.**

b) Impaired function of the posterior lobe of the pituitary gland. (3 marks)
- **Impaired function of posterior pituitary glands causes no ADH produced.**
- **∴ ADH cannot act on distal tubule and collecting duct to reabsorb more water**
- **However, the low water content can not trigger posterior pituitary gland to produce ADH, the person will suffer from dehydration.**

33. Describe how the brain and the endocrine system work together to maintain homeostasis when the osmotic pressure (high solute concentration) of the blood increases. (8 marks)

See # 20

34. 

Using human subjects, an investigation was carried out to look at the effect of drinking distilled water on the production and composition of the urine. At the start of the experiment the subjects emptied their bladders and then rapidly drank 800 mL of distilled water. The subjects then emptied their bladders at regular intervals and the volume of urine and its salt concentration were recorded. The results are shown on the chart below.

By referring to the charts and by using your knowledge of kidney function, answer the following:

a) Explain why the volume of urine has changed between 30 and 90 minutes. (2 marks)

- **The person drinks 800mL water, the water volume increases in the body, so blood volume and pressure increase.**
- **Less water will be reabsorbed from the tubules in the nephron, so the volume of urine increases between 30 and 90 minutes.**

b) Explain why the volume of urine has changed between 90 and 150 minutes. (2 marks)

- **As time passes, the volume of urine decreases.**
- **Water reabsorption increases (urine production decreases) until BP and blood volume are back to normal level (homeostasis).**

c) In another similar experiment the subjects consumed 200 mL of isotonic saline, but the volume of urine remained normal. Explain why. (2 marks)

- **Isotonic saline has the same salt concentration with the salt in the body.**
- **Drinking isotonic saline does not cause a concentration gradient of water and salt. Hence, the subject's urine production remained normal.**

d) Explain why the salt concentration of urine changed between 30 and 90 minutes (2 marks)

- **Between 30 and 90 minutes, the subject's body still has a high water volume.**
- **Excess water dilutes the salts thus decreasing the concentration of salts in the urine**

e) State two factors (regarding human subjects) that would have to be kept constant during this experiment. (2 marks)

1. the salt concentration
2. amount of water in body, blood volume.