

Chapter 13 – The Urinary System

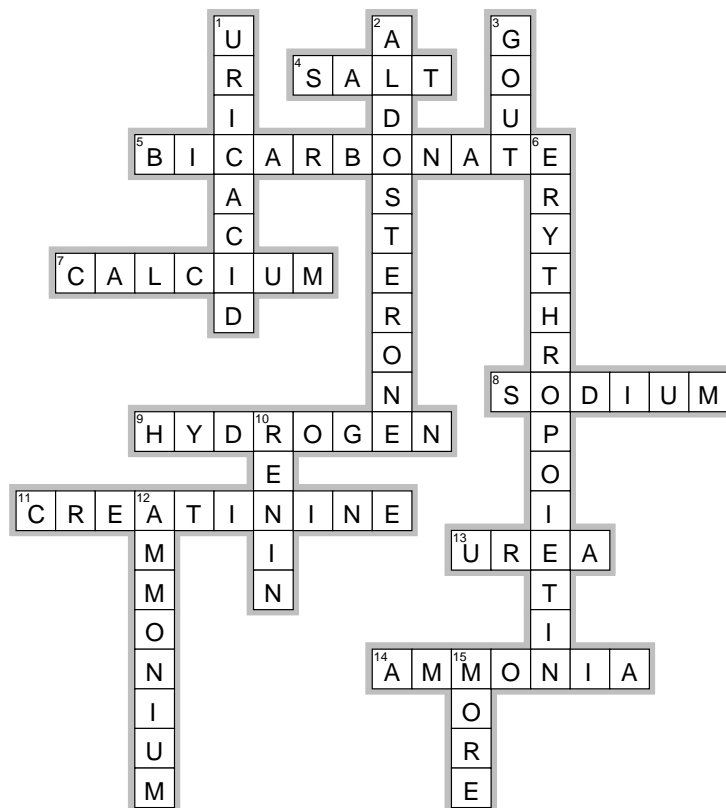
Complete using BC Biology 12, page 408 - 435

13.1 The Urinary System

pages 412- 413

1. As the kidneys produce urine, they carry out the following four functions
 - a. Excretion of metabolic wastes
 - i. List some of the waste products: urea (most), ammonia/ammonium, creatinine, uric acid
 - b. Osmoregulation (regulation of water-salt balance)
 - i. How are blood volume and blood pressure related? when blood volume increases, blood pressure increases
 - c. Regulation of acid-base balance
 - i. What is the average pH of urine? ~6
 - d. Secretion of hormones
 - i. When might the kidneys secrete **erythropoietin**? When the oxygen demand increases, and the body needs more red blood cells to transport oxygen

2. Complete the crossword using terms from the “Functions of the Urinary Systems”



EclipseCrossword.com

Across

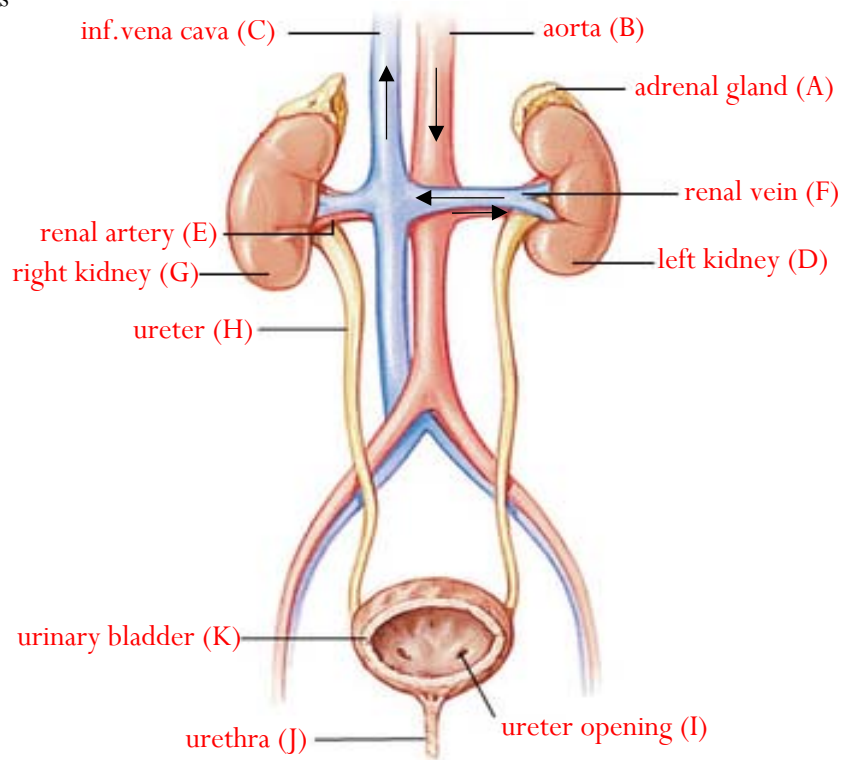
4. Blood volume is intimately associated with the balance of the body.
5. Kidneys regulate levels of other ions such as K^+ , Ca^{2+} and _____.
7. Kidneys help activate vitamin D from the skin which promotes the absorption of this element from the digestive tract.
8. Aldosterone promotes the reabsorption of _____ ions by the kidneys.
9. Kidneys maintain blood pH by excreting _____ ions and reabsorbing bicarbonate ions.
11. Product of the breakdown of a high-energy phosphate reserve molecule
13. Byproduct of amino acid metabolism
14. Very toxic to cells (NH_3)

Down

1. Results from the breakdown of nucleotides.
2. Hormone released from the adrenal cortex of the adrenal glands.
3. Painful ailment caused by crystals of uric acid precipitating in the joints.
6. Hormone which stimulates red blood cell production.
10. Enzyme that leads to secretion of hormone aldosterone.
12. Some ammonia is excreted as this ion (NH_4^+)
15. Human urine is (more/less) acidic than blood due foods we eat

3. Label the diagram with the terms

- A. adrenal glands
- B. aorta
- C. inferior vena cava
- D. left kidney
- E. renal artery
- F. renal vein
- G. right kidney
- H. ureter
- I. ureter opening
- J. urethra
- K. urinary bladder

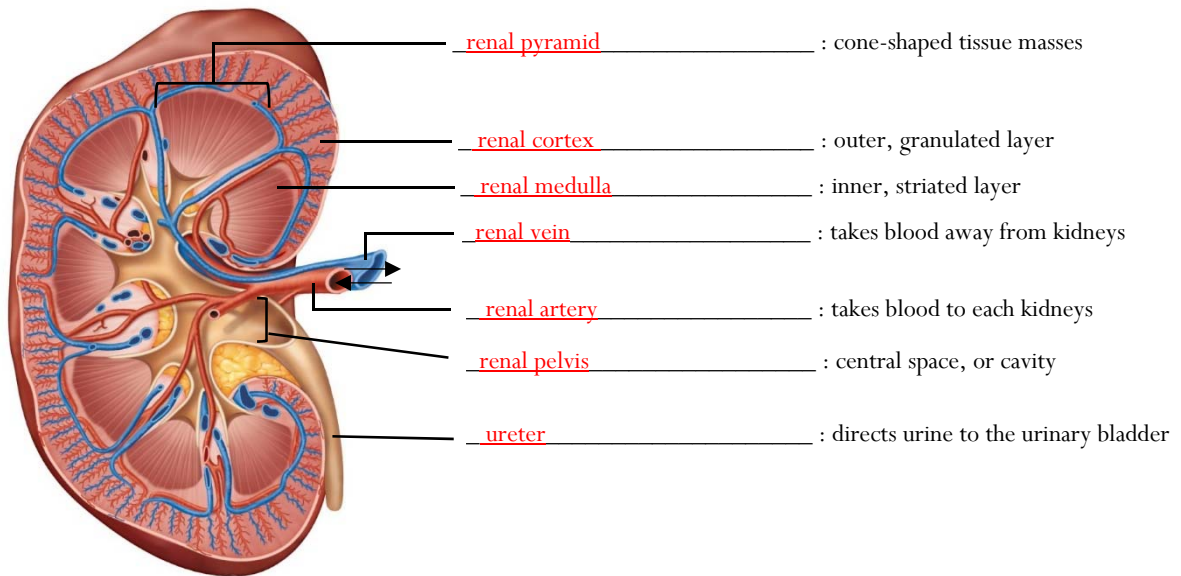


4. The kidneys are paired, bean-shaped, reddish-brown organs located near the small of the back. They lie behind the peritoneum where they receive some protection from the lower rib cage. Each one is covered by a tough fibrous connective tissue layer called a renal capsule. The concave side of each kidney has a depression called the hilum where a renal artery enters and a renal vein and a ureter exit the kidney.

5. Summarize the structure and function of each of the following structures

- a. ureters: small, muscular tubes (~25 cm long, 5 mm in diameter). Perform peristalsis to cause urine to enter the bladder.
- b. urinary bladder: expandable due to inner folding (rugae) and has 3 openings (2 from ureters and 1 to the urethra). Stores urine until it can be removed from body (so we don't continually leak 😊). "Incontinence" is the involuntary loss of urine if sphincter muscles can't be properly controlled
- c. urethra: tube that extends from urinary bladder to an external opening. Shorter in females and longer in males as the urinary and reproductive systems are combined and the urethra carries both urine and semen)

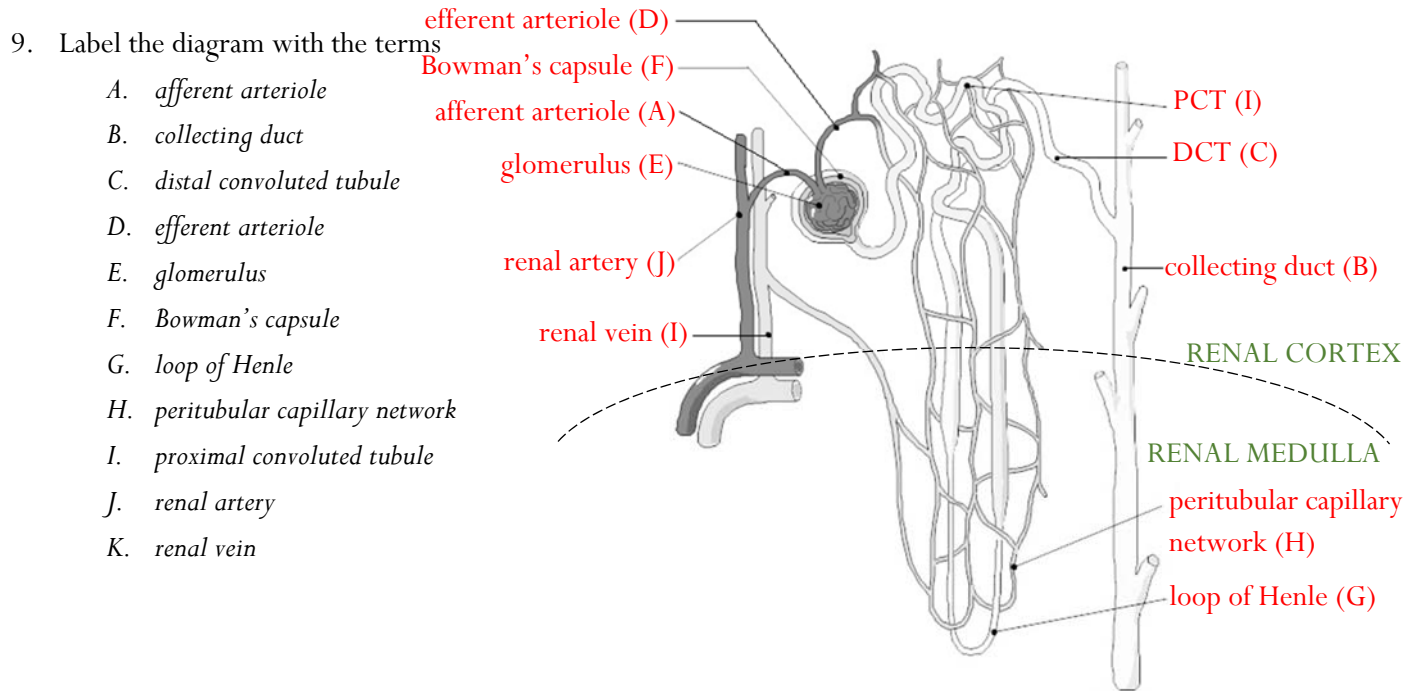
6. Identify the detailed parts of the kidney as indicated below.



7. Each kidney is composed of over one million individual units called nephrons. Each has its own blood supply, including two capillary regions. From the renal artery, an afferent arteriole leads to the glomerulus. Blood leaving the glomerulus enters the efferent arteriole which takes blood to the peritubular capillary network which surrounds the rest of the nephron. From there blood goes into a venule that joins the renal vein.

8. Match the parts of a nephron to their descriptions

<u>B</u> _____ Bowman's capsule	A. numerous mitochondria to aid in tubular excretion
<u>E</u> _____ proximal convoluted tubule	B. cuplike structure that surrounds the glomerulus, site of filtration
<u>C</u> _____ loop of Henle	C. mainly in the medulla; made of simple squamous epithelium
<u>A</u> _____ distal convoluted tubule	D. has many nephrons connected to it; carries urine to renal pelvis
<u>D</u> _____ collecting ducts	E. contains tightly packed microvilli for maximum reabsorption



10. Draw a dotted line through the above nephron to indicate the portions found in the **renal cortex** versus **renal medulla**. Label the regions.

11. Urine is formed through the following 3 processes. Use the table to compare them.

	Pressure Filtration	Selective Reabsorption	Tubular Excretion
Site of action or direction of flow	Glomerulus to the Bowman's Capsule	Proximal Convoluted Tubule (PCT) to the Peritubular Capillary Network	Peritubular Capillary Network to the Distal Convoluted Tubule (DCT)
Components being transferred	- Water - Nitrogenous wastes - Nutrients - Salts (ions)	- Most water - Nutrients - Required salts (ions)	- Hydrogen ions - Potassium ions - Creatinine - Drugs (antibiotics)
Name of fluid after completing this process	Glomerular Filtrate	Filtrate	Urine

12. Trace the path of each of the following through the nephron beginning in the glomerulus. Be as specific as possible with respect to structure and process.

- a. nutrients: glomerulus (pressure filtration) → Bowman's capsule → proximal convoluted tubule (PCT) (selective reabsorption) → peritubular capillary network
- b. plasma proteins: glomerulus → efferent arteriole → peritubular capillary network → renal vein
 * Doesn't leave the blood stream
- c. antibiotics: glomerulus → efferent arteriole → peritubular capillary network (tubular excretion) → distal convoluted tubule (DCT) → collecting duct

Osmoregulation

13. Excretion of a hypertonic urine (one that is more concentrated than blood) is dependent of the reabsorption of water from the loop of Henle and the collecting duct. It requires:

(1) Reabsorption of Salt

- Where are sodium ions reabsorbed?
 - proximal tubule (67%)
 - ascending limb of loop of Henle (25%)
 - distal tubule and collecting duct (~7%)
- The hormones involved in regulating blood pressure and volume (*Figure 13.7 helps*)
 - Low blood pressure triggers the juxtaglomerular apparatus to secrete renin which triggers the adrenal cortex to secrete aldosterone causing the kidneys to excrete of K^+ and absorb Na^+ . This causes an increase in water reabsorption therefore increasing blood volume and subsequently blood pressure rises to normal.
 - High blood pressure triggers the heart to secrete atrial natriuretic hormone (ANH) which causes kidneys to excrete more Na^+ and water in the urine. This causes blood volume to decrease and blood pressure returns to normal.

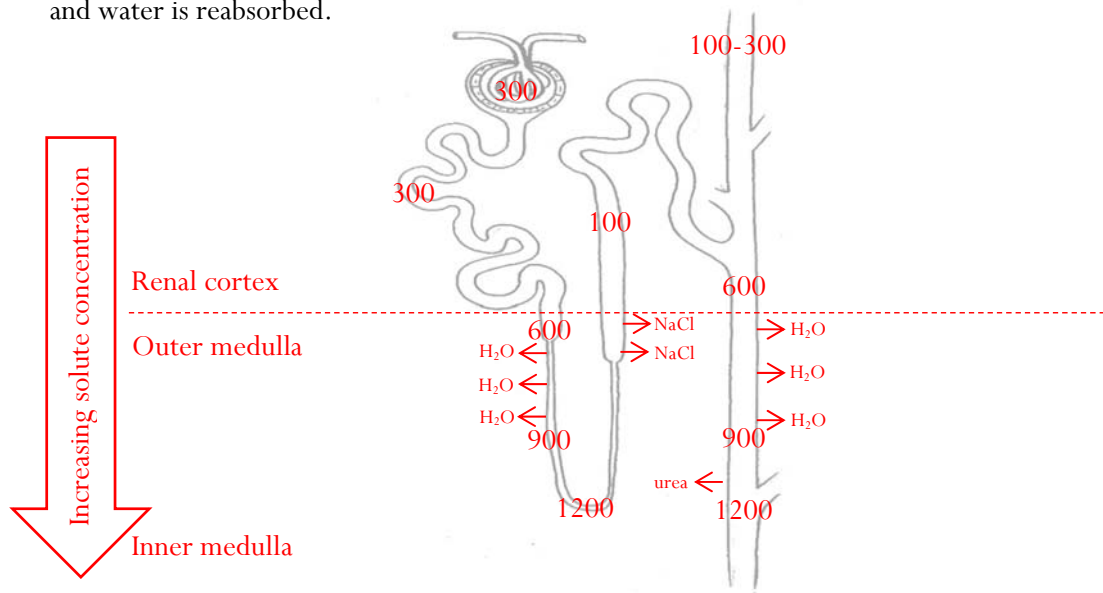
(2) Establishment of a Solute Gradient

- The loop of Henle is made up of a descending limb and an ascending limb.
- The concentration of salt is greater in the direction of the inner medulla. Note that water cannot leave the ascending limb because that portion is impermeable to water.
- The increasing solute concentration in the renal medulla is thought to be partially due to salt but thought mainly to be due to urea leaking from the lower portion of the collecting duct.

(3) Reabsorption of Water

- Why does water leave the nephron and enter the medulla as it travels through the entire descending limb of the loop of Henle? Due to the osmotic gradient within the renal medulla, the further down the more "salty" it is so more water will leave the nephron
- Kidneys are able to regulate the amount of water that exits the body. When it needs to remove excess water, urine that is hypotonic to the general body fluids is produced (more water in the urine). If dehydrated, the posterior pituitary gland releases antidiuretic hormone (ADH) which causes the collecting duct to become more permeable (increases the number of aquaporins inserted in the cells) and the kidneys are able to reclaim more water (less water in the urine).
- Why is urine more concentrated for the first urine in the morning? More ADH is produced at night so we won't disrupt our sleep by having to urinate as often

14. Use Figure 13.8 and the basic diagram of the nephron below to illustrate how a solute gradient is established and water is reabsorbed.



15. Define **diuretics**: _____

- How do each of the following act as a diuretic?
 - alcohol: _____
 - caffeine: _____
 - prescription drugs: _____
- Why is it risky to use diuretics for quick weight loss? _____

Acid-Base Balance

16. If the blood pH rises above 7.4, a person is said to have _____ and if the blood pH drops below 7.4, a person is said to have _____. The body uses several mechanisms to maintain a homeostatic pH such as:

(1) *Acid-Base Buffer Systems*

- Draw the formulas for the most common blood buffers

(2) *Respiratory Centre*

- Describe how pH is regulated by the respiratory center. _____

(3) *The Kidneys* – slower acting than the first two, but have a more powerful effect on pH

- For sake of simplicity we can think of the kidneys as reabsorbing _____
_____ from the tubular fluid and excreting excess _____
into the urine (when the blood is too acidic).
- Name two other means of buffering
 - _____
 - _____

13.4 Disorders of the Urinary System

pages 422 - 425

17. Many major illnesses that affect other parts of the body can also cause serious kidney disease. Most tend to damage the nephrons resulting in decreased filtration and eventual kidney failure. Name some of the illnesses that can affect the kidneys.

- _____

18. What is one of the first signs of kidney damage? _____

19. Complete the table. Your knowledge of the disorders will not be tested but rather is provided for interest.

Disorder	Description
Disorders of the Kidneys	
	Infection of the kidneys. Where do most infections spread from?
	Hard granules that form in the renal pelvis (composed of calcium, phosphate, uric acid, and protein).
	Urea and other waste products accumulating in the blood due to more than _____ of the nephrons being destroyed.
Disorders of the Urinary Bladder and Urethra	
	Results from bacteria gaining access to the bladder. Why is this condition more prevalent in women than men?
	Inflammation of the bladder
	Inflammation of the urethra
	Most commonly occur as a result of another condition that interferes with normal urine flow.
	Most common type of cancer of the urinary system. If the organ needs to be removed, where are the ureters re-routed?

20. Explain the process of **hemodialysis**. _____

Chapter Questions

pages 432 - 435

- | | | | |
|----------|-----------|-----------|-----------|
| 1. _____ | 7. _____ | 13. _____ | 19. _____ |
| 2. _____ | 8. _____ | 14. _____ | 20. _____ |
| 3. _____ | 9. _____ | 15. _____ | 21. _____ |
| 4. _____ | 10. _____ | 16. _____ | 22. _____ |
| 5. _____ | 11. _____ | 17. _____ | 23. _____ |
| 6. _____ | 12. _____ | 18. _____ | 24. _____ |

25. Identify the part of the nephron as described.

- | | |
|----------|----------|
| a. _____ | i. _____ |
| b. _____ | j. _____ |
| c. _____ | k. _____ |
| d. _____ | l. _____ |
| e. _____ | m. _____ |
| f. _____ | n. _____ |
| g. _____ | o. _____ |
| h. _____ | |

26. Explain the connection between the urinary system and the following systems

- a. nervous system _____

- b. digestive system _____

- c. endocrine system _____

- d. lymphatic system _____

- e. circulatory system _____

- f. respiratory system _____

- g. reproductive system _____

27. Which of the statements describes the function of the kidneys? (yes or no)

- | | | | |
|----------|----------|----------|----------|
| a. _____ | c. _____ | e. _____ | g. _____ |
| b. _____ | d. _____ | f. _____ | h. _____ |

i. _____

j. _____

29. Compare and contrast aldosterone and ADH

	Aldosterone	ADH
Type of molecule		
Origin		
Where it works		
Regulation		

30. Path of blood of red blood cell:

renal artery → _____ → _____ → _____
→ _____ → renal vein

32. _____

39. _____

40. _____

45. _____

51. _____

52. _____

53. _____

57. _____

Mark the review questions using the answer key on pages 550 - 552