13.1 The Urinary System

1. As the kidneys produce urine, they carry out the following four functions
   a. __________________________
      • List some of the waste products: __________________________
   b. __________________________
      • How are blood volume and blood pressure related? __________________________
   c. __________________________
      • What is the average pH of urine? ______
   d. __________________________
      • When might the kidneys secrete erythropoietin? __________________________

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

Across

4. Blood volume is intimately associated with the balance of the body.
5. Kidneys regulate levels of other ions such as K⁺, Ca²⁺ 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 (NH₃)

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 (NH₄⁺)
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 __________________ are paired, bean-shaped, reddish-brown organs located near the small of the back. They lie behind the ____________________ where they receive some protection from the lower rib cage. Each one is covered by a tough fibrous connective tissue layer called a _______________. The concave side of each kidney has a depression called the ____________ where a ________________ enters and a ________________ and a ______________ exit the kidney.

5. Summarize the structure and function of each of the following structures
   a. ureters: ____________________________________________________________
      ____________________________________________________________
      ____________________________________________________________
   b. urinary bladder: ___________________________________________________
      ____________________________________________________________
      ____________________________________________________________
   c. urethra: ___________________________________________________________
      ____________________________________________________________
6. Identify the detailed parts of the kidney as indicated below.

- ___________________________: cone-shaped tissue masses
- ___________________________: outer, granulated layer
- ___________________________: inner, striated layer
- ___________________________: takes blood away from kidneys
- ___________________________: takes blood to each kidneys
- ___________________________: central space, or cavity
- ___________________________: directs urine to the urinary bladder

7. Each kidney is composed of over ____________________________ individual units called _____________________________. Each has its own blood supply, including two capillary regions. From the renal artery, an ____________________________ arteriole leads to the _____________________________. Blood leaving the glomerulus enters the ____________________________ arteriole which takes blood to the ____________________________ 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

- _______ Bowman’s capsule  A. numerous mitochondria to aid in tubular excretion
- _______ proximal convoluted tubule  B. cuplike structure that surrounds the glomerulus, site of filtration
- _______ loop of Henle  C. mainly in the medulla; made of simple squamous epithelium
- _______ distal convoluted tubule  D. has many nephrons connected to it; carries urine to renal pelvis
- _______ collecting ducts  E. contains tightly packed microvilli for maximum reabsorption
9. Label the diagram with the terms
   A. afferent arteriole
   B. collecting duct
   C. distal convoluted tubule
   D. efferent arteriole
   E. glomerulus
   F. Bowman’s capsule
   G. loop of Henle
   H. peritubular capillary network
   I. proximal convoluted tubule
   J. renal artery
   K. renal vein

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.

<table>
<thead>
<tr>
<th></th>
<th>Pressure Filtration</th>
<th>Selective Reabsorption</th>
<th>Tubular Excretion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site of action or</td>
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<tr>
<td>direction of flow</td>
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<td>Components being</td>
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<td>Name of fluid after</td>
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<td>completing this process</td>
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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: ____________________________________________
   b. plasma proteins: ______________________________________
   c. antibiotics: _________________________________________
Osmoregulation

13. Excretion of a ________ urine (one that is more concentrated than blood) is dependent on the reabsorption of water from the ________ and the ________. It requires:

1) Reabsorption of Salt
   - Where are sodium ions reabsorbed?
     - __________________________ (67%)
     - __________________________ (25%)
     - __________________________ (~7%)
   - The hormones involved in regulating blood pressure and volume (Figure 13.7 helps)
     - Low blood pressure triggers the ________ to secrete ________ which triggers ________ to secrete ________ causing the kidneys to excrete of K⁺ and absorb Na⁺. This causes an increase in ________ reabsorption therefore increasing blood ________ and subsequently blood ________ rises to normal.
     - High blood pressure triggers the heart to secrete ________ which causes kidneys to excrete more ________ and ________ in the urine. This causes blood volume to ________ and blood pressure returns to normal.

2) Establishment of a Solute Gradient
   - The loop of Henle is made up of a ________ limb and an ________ limb.
   - The concentration of salt is ________ in the direction of the ________. Note that ________ cannot leave the ________ 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 ________ leaking from the lower portion of the ________.

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? ________
   - Kidneys are able to regulate the amount of water that exits the body. When it needs to remove excess water, urine that is ________ to the general body fluids is produced (more water in the urine). If dehydrated, the ________ gland releases ________ (ADH) which causes the collecting duct to become more permeable (increases the number of ________ 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? ________
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 and excreting excess into the urine (when the blood is too acidic).
- Name two other means of buffering
  o 
  o 

13.4 Disorders of the Urinary System

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.

<table>
<thead>
<tr>
<th>Disorder</th>
<th>Description</th>
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</thead>
</table>
| 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**.

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<table>
<thead>
<tr>
<th>Chapter Questions</th>
<th>1. _____</th>
<th>7. _____</th>
<th>13. _____</th>
<th>19. _____</th>
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<td>18. _____</td>
<td>24. _____</td>
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</tbody>
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25. Identify the part of the nephron as described.

a. __________________________

b. __________________________

c. __________________________

d. __________________________

e. __________________________

f. __________________________

g. __________________________

h. __________________________

i. __________________________

j. __________________________

k. __________________________

l. __________________________

m. __________________________

n. __________________________

o. __________________________

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. ____  d. ____  g. ____  j. ____
   b. ____  e. ____  h. ____
   c. ____  f. ____  i. ____

29. Compare and contrast aldosterone and ADH

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<thead>
<tr>
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<th>ADH</th>
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</thead>
<tbody>
<tr>
<td>Type of molecule</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Origin</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Where it works</td>
<td></td>
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<tr>
<td>Regulation</td>
<td></td>
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30. Path of blood of red blood cell:

    renal artery \( \rightarrow \) \( \) \( \) \( \) \( \rightarrow \) \( \) \( \) \( \) \( \) \( \rightarrow \) \( \) \( \) \( \) \( \) \( \rightarrow \) \( \) \( \) \( \) \( \) \( \rightarrow \) \( \) \( \) \( \) \( \) \( \rightarrow \) \( \) \( \) \( \) \( \) \( \rightarrow \) \( \) \( \) \( \) \( \) \( \rightarrow \) \( \) \( \) \( \) \( \) \( \rightarrow \) renal vein

32. 


39. 


40. 


45. 


51. 


52. 


53. 


57. 


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