

Name: \_\_\_\_\_

**Physiology: The Renal System Worksheet**  
**Directions: Write in and circle best answer on this sheet.**

Answers to questions can be found in chapter 21 of OER textbook, the lecture notes and other sources online. Use the answers to the questions to complete the multiple choice questions at the end.

1. The renal system is composed of what structures?
2. Where are the kidneys located in the body?
3. Typically one kidney weighs about \_\_\_\_\_ oz., and is about \_\_\_\_\_ inches long, but the two kidneys receive about \_\_\_\_\_ % of cardiac output, about the same % as the brain, which is high.
4. Why do the kidneys receive such a large % of CO? \_\_\_\_\_.
5. Name and define the 4 Renal Processes.
  - 1)
  - 2)
  - 3)
  - 4)
6. In lecture slides and notes the key **Specific Functions** of the renal system are listed: Describe them.
  - 1)
  - 2)
  - 3)
  - 4)
  - 5)
  - 6)
  - 7)

**The Nephron is the Functional Unit of the Kidney**

7. The medulla is the (inner/outer) layer and the cortex is the (inner/outer) of the kidney. The brown outmost layer of the kidney is called the renal \_\_\_\_\_. The nephron is the \_\_\_\_\_ of the kidney. In each kidney, there are approx. \_\_\_\_\_ nephrons. In the human kidney, the majority of nephrons (about \_\_\_\_ %) are called \_\_\_\_\_ nephrons, while the other nephrons (about \_\_\_\_ %) are called \_\_\_\_\_ nephrons.

8. What is a "Portal System" in the cardiovascular system?

9. List the 3 portal systems in the body:

1) \_\_\_\_\_; 2) \_\_\_\_\_; 3) \_\_\_\_\_.

10. The kidneys have a portal system. Succinctly, what is the main purpose of the renal portal system?

11. What are the three major components of the **renal corpuscle**?

1)

2)

3)

12. What process takes place at the glomerulus? \_\_\_\_\_.

13. Name the three major components of the **renal tubule** and the most significant activity there.

1)

2)

3)

14. Compare a **cortical nephron** to a **juxtamedullary nephron**, include 3 ways they are different:

15. How much **plasma** is filtered per day by the kidneys? \_\_\_\_\_ L/day.

16. How much **urine** (on average) is produced by the body per day? \_\_\_\_\_ L/day.

17. What happens to the filtrate that is not excreted in the urine? It is \_\_\_\_\_.

18. The fluid (filtrate) from the Bowman's capsule that moves into the proximal convoluted tubule (PCT) has an osmolarity of about \_\_\_\_\_ mOsM, which is nearly \_\_\_\_\_ -osmotic with plasma.

19. At the end of the proximal convoluted tubule (PCT) about \_\_\_\_\_% of the filtrate remains in the tubule, thus about \_\_\_\_\_% has been reabsorbed. The osmolarity of this fluid is \_\_\_\_\_ mOsM. Based on this, the proximal convoluted tubule is the primary site of (filtration?/reabsorption?/secretion?).

20. The filtrate at the hair pin loop of the **loop of Henle** is usually about \_\_\_\_\_ mOsM, this is (isosmotic/hyperosmotic/hyposmotic) to plasma. By the end of the ascending loop of Henle, the filtrate has an osmolarity of \_\_\_\_\_ mOsM. Thus, it can be said that the loop of Henle recovers both \_\_\_\_\_ and \_\_\_\_\_ from the filtrate and returns it to the body to keep.

21. Both \_\_\_\_\_ and \_\_\_\_\_ are reabsorbed in the distal convoluted tubule (DCT) and the three substances most commonly **secreted** at the DCT are \_\_\_\_\_, \_\_\_\_\_ and \_\_\_\_\_.

22. By the end of the DCT the filtrate has an osmolarity of \_\_\_\_\_ mOsM, and by the end of the collecting duct the filtrate has an osmolarity that can range from \_\_\_\_\_ to \_\_\_\_\_ mOsM. The average volume of urine is about \_\_\_\_\_ L/day. Both the osmolarity and the volume of urine depend of the body's need to conserve or excrete \_\_\_\_\_ and \_\_\_\_\_.

### Renal Filtration

23. What % of the plasma volume that enters the glomerulus is actually filtered? \_\_\_\_\_ %.

24. How much of that filtered plasma is becomes urine and is excreted? \_\_\_\_\_ %

25. The driving force for glomerular filtration is: \_\_\_\_\_.

1) The \_\_\_\_\_ pressure of blood forces fluid out through leaky endothelium of capillaries.

2) The \_\_\_\_\_ pressure inside glomerular capillaries is higher than that of the fluid within the Bowman's capsule. This is why fluid moves from the glomerulus into the \_\_\_\_\_.

26. The hydrostatic pressure (HP) of the glomerulus is \_\_\_\_\_ mmHg. This force (opposes/favors) fluid movement into the Bowman's capsule, i.e., this force (opposes/favors) filtration. The HP of the Bowman's space (or capsule) is \_\_\_\_\_ mmHg. This force (opposes/favors) fluid movement into the capsule. The colloid osmotic pressure (COP) of the blood in the glomerulus is \_\_\_\_\_ mmHg. This force (opposes/favors) fluid movement into the Bowman's capsule. If you summate these 3 forces that influence fluid movement across the glomerulus, the *net* force is \_\_\_\_\_ mmHg. Therefore, the net direction of fluid movement is from the \_\_\_\_\_ to the \_\_\_\_\_.

### Glomerular Filtration Rate

27. Define glomerular filtration rate (GFR):

28. An average value for **GFR** is \_\_\_\_\_ liters/day or \_\_\_\_\_ ml/min.

29. The total body plasma is \_\_\_\_\_ L; this means the kidneys filter the plasma \_\_\_\_\_ per day!

### Autoregulation of GFR in the Nephron

30. What are the two types of **autoregulation** in the nephron?

1) \_\_\_\_\_ and 2) \_\_\_\_\_

31. What is the **myogenic** (stretch) response in the nephron?

32. The DCT communicates with the afferent arterioles via the region called the \_\_\_\_\_. What does the abbreviation "JG" stand for? \_\_\_\_\_. The JG cells secrete an enzyme called \_\_\_\_\_, which has a role in \_\_\_\_\_ and \_\_\_\_\_ balance.

### Hormones and Autonomic Neurons also Influence GFR

33. In neural control of GFR (sympathetic/parasympathetic) neurons release (ACh/NE) onto ( $\alpha$ ,  $\beta_1$ ,  $\beta_2$ , nicotinic or muscarinic) receptors, causing (vasodilation/vasoconstriction) of renal arterioles.

34. Vasoconstriction of the **afferent** arteriole will (increase/decrease) its resistance, will (increase/decrease) hydrostatic pressure in the glomerulus and will (increase/decrease) GFR.

35. Vasoconstriction of the **efferent** arteriole will (increase/decrease) its resistance, will (increase/decrease) hydrostatic pressure in the glomerulus and will (increase/decrease) GFR.

36. Hormones influencing arteriole resistance and GFR include \_\_\_\_\_, which is a potent vasoconstrictor and a group of regulators called \_\_\_\_\_, which are vasodilators.

36. Why is a decrease in GFR when blood pressure falls below normal a protective and adaptive response?

### Renal Reabsorption

37. The bulk of reabsorption in the nephron takes place in the \_\_\_\_\_.

38. Which ion plays a key role in bulk reabsorption in the proximal (convoluted) tubule? \_\_\_\_\_.

39. List some molecules that are transported using  $\text{Na}^+$ -linked secondary active transport:

\_\_\_\_\_.

40. List and briefly describe three *characteristics* of renal **protein carrier** transport (with examples):

1)

2)

3)

41. Below saturation point, the rate of transport is proportional to \_\_\_\_\_.

42. Should glucose normally be found in the urine? \_\_\_\_\_. The term for glucose in urine? \_\_\_\_\_.

43. Should protein normally be found in the urine? \_\_\_\_\_. The term for protein in urine? \_\_\_\_\_.

44. The condition characterized by abnormally high levels of **nitrogen compounds** in the blood is called \_\_\_\_\_, whereas when there is an accumulation of **urea** in the blood it's called \_\_\_\_\_.

45. What is **caliectasis**? \_\_\_\_\_.

46. Define **nephritis**: \_\_\_\_\_. It can cause excessive \_\_\_\_\_ in urine.

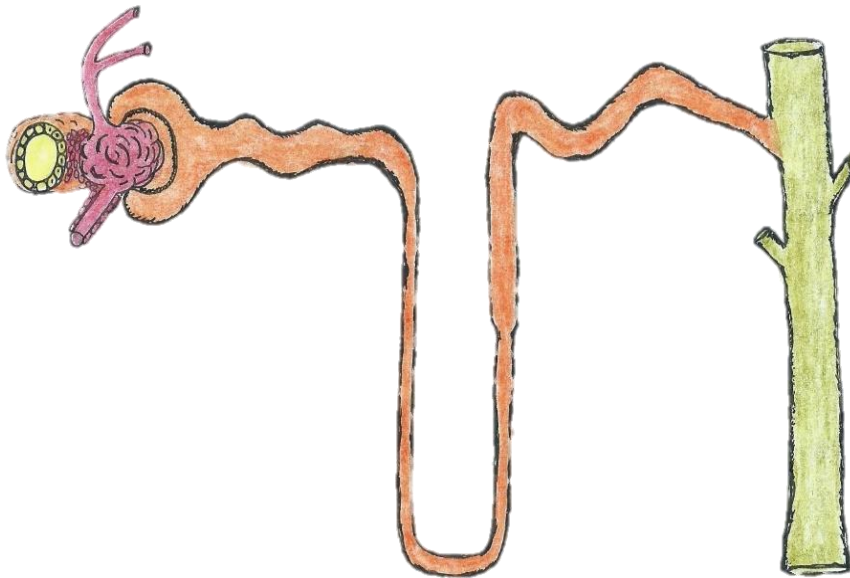
47. Inflammation or infection of the bladder is called \_\_\_\_\_, which can causes acute or chronic pain, discomfort, or urinary frequency or hesitancy.

48. If there is pain or discomfort during urination because of an infection, inflammation, or irritation of the bladder, urethra, or external genitals, in general this is termed \_\_\_\_\_.

49. In **rhabdomyolysis**, why does urine become dark? \_\_\_\_\_.

50. Fill in the following table for the signal molecules that regulate the renal system.

Molecule	Source	Stimulated into Action By:
Renin		
Angiotensinogen		
Angiotensin I		
Angiotensin II		
Vasopressin (ADH)		
Aldosterone		



Label the structures in the drawing above, include all of the terms and structures used in class. Use arrows to show where the 4 renal processes (**F**, **R**, **S** and **E**) occur in the nephron and collecting duct above.

**Multiple Choice Questions.** Use the worksheet answers to complete the multiple choice questions.

1. Urine is carried to the urinary bladder by  
a) blood vessels   b) lymphatics   c) the ureters   d) the urethra   e) all are correct
2. Which structure is not part of the blood circulation through the kidney?  
a) vasa recta   b) loop of Henle   c) glomerulus   d) renal corpuscle   b) peritubular capillary
3. The blood flow through the kidney includes a feature seen in only a few organs. What is it?  
a) a portal system   b) arterial shunts   c) vascular sinuses   d) highly oxygenated veins   e) anastomoses
4. The Bowman's capsule, the Bowman's space and glomerulus make up the  
a) renal pyramid   b) loop of Henle   c) renal corpuscle   d) renal papilla   e) collecting system
5. Which of the 4 kidney process directly requires energy to occur?  
a) filtration   b) reabsorption   c) secretion   d) excretion
6. The portion of the nephron that attaches to (leads into) the collecting duct is the  
a) loop of Henle   b) proximal tubule   c) distal tubule   d) collecting duct   e) minor calyx
7. In normal kidneys, blood cells and plasma proteins are  
a) filtered then reabsorbed   b) secreted then reabsorbed   c) filtered and secreted   d) never filtered
8. The force that favors glomerular filtration is the  
a) reabsorption of fluids   b) osmotic pressure in the glomerular capillaries  
c) fluid pressure produced by the displacement of the fluid in the lumen of the renal tubules  
d) ATP-dependent processes in the nephron   e) blood pressure in the glomerular capillaries
9. Which statement about autoregulation is true?  
a) Myogenic response is the intrinsic ability of vascular smooth muscle to respond to pressure changes  
b) Myogenic response is a paracrine signaling mechanism  
c) In tubuloglomerular feedback, stretch-sensitive ion channels open, contracting smooth muscle  
d) In myogenic response, macula densa cells send paracrine messages to neighboring afferent arteriole
10. The primary function of the proximal convoluted tubule (PCT) is  
a) filtration   b) reabsorption of ions, organic molecules, and water   c) secretion of acids and ammonia  
d) secretion of drugs   e) adjusting the urine volume
11. The specialized cells found in the Bowman's capsule that generate the filtration slits are called \_\_\_\_\_.  
a) Mesangial cells   b) Juxtaglomerular cells   c) Granular cells   d) Fenestrated cells   e) Podocytes
12. Cell **volume** (and therefore cell function) in most cells is dependent upon careful **regulation** of  
a) the volume of extracellular fluid   b) blood pressure   c) the osmolarity of extracellular fluid  
d) the permeability of cell membranes   e) the resting membrane potential
13. The hormone that directly controls **water reabsorption** of kidneys is \_\_\_\_\_.