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PRE-LAB EXERCISES

Open Atlas. From the Views menu, go to System Views and scroll down to Urinary System Views.

You are responsible for the identification of all bold terms.

A. Urinary System Overview

In the Urinary System Views section, select View 1. Urinary System (M). Locate the paired, bean-shaped kidneys near the top of the view, select one of them to open the content box, and use the up-arrow to find and choose Urinary System from the list. Then, select the book icon, read the description of the urinary system, and use this information to answer the following questions.
1. List the organs of the urinary system and locate them in the view. You may want to use the Fade Others tool to get a clearer view of the highlighted structures.  
**Kidneys, ureters, urinary bladder, and urethra**

2. Describe the main function of the urinary system.  
The urinary system filters wastes (impurities) and other unwanted substances from the blood (and excretes them as fluid waste called urine).

3. What is the excretory product of the urinary system?  
**Urine**

4. In men, the *urethra* passes through which two organs of the reproductive system?  
**The penis and the prostate**
Go back to the Urinary System Views and open View 2. Urinary System (F) to locate all the organs of the female urinary system. Complete the following statement so it accurately compares the male and female urinary systems.

5. In the **male** urinary system, the **urethra** is much longer.
B. Urinary System Overview

In the Urinary System Views section, select View 3. Pelvic Region (M). Use this view to answer the following questions.

1. Adjust the view so you can see the paired **kidneys** near the top and rotate the view to see the dorsal portion of the kidneys. How would you describe their relationship to the intestines and the spine?

   The kidneys are located on either side of the vertebral column, behind the intestines.
2. Locate the bladder. Note that it rests on the pelvic floor. Select the bladder and use the up-arrow in the content box to find and choose Urinary System from the list. Use the Fade Others tool to get a clearer view of the highlighted structures. Locate the urethra as it leaves the bladder and follow its path. The first section of the male urethra passes through the **prostate (gland)**.

3. The last section of the male urethra travels through the **spongy (cavernous, or corpus spongiosum)** portion of the penis and the **glans penis** (the tip of the penis).

**Go back to the Urinary System Views and open View 4. Pelvic Region (F). Use this view to answer the following questions.**
1. Adjust the view so you can see the anterior peritoneum covering the abdominal organs. Select the peritoneum and use the book icon to read the definition. The peritoneum is a ____serous____ membrane. The inner layer forms the lining that covers the ____internal organs____.
2. Rotate the view, select one of the kidneys, and use the book icon to read the definition. The kidneys are defined as retroperitoneal organs. What do you think “retroperitoneal” means?

**Behind, or dorsal to, the peritoneum**

3. Hide the peritoneum and rotate the view to see the bladder from the side. The female bladder lies on the pelvic floor underneath the ___uterus____.
IN-LAB EXERCISES

Open Atlas. From the Views menu, go to System Views and scroll down to Urinary System Views.

A. The Kidneys: Vasculature

In the Urinary System Views section, select View 9. Renal Vasculature (M). Use this view to answer the following questions.

1. In this view, you can see a cone-shaped endocrine gland on top of each kidney. These are the ______ adrenal glands_____, which release hormones affecting the function of the kidneys.
2. Select either of the large arteries entering the kidneys to view the renal blood supply and use the book icon to read the definition.
   
   a. These large arteries are branches of the **aorta**.
   
   b. The large arteries entering the kidneys are called the **renal arteries**.
   
   c. Which of these arteries is higher? **Left**
   
   d. Which is longer? **Right**

3. Select either of the large veins leaving the kidneys to view the venous drainage of the kidneys and use the book icon to read the definition.
   
   a. These large vessels drain into the **inferior vena cava**.
   
   b. Which of these veins is higher? **Left**
   
   c. Which is longer? **Left**

Note that as blood enters the kidneys, it brings oxygen to renal tissues and is filtered by the kidneys. Blood leaving the kidneys is depleted of oxygen and has been filtered.
B. The Kidneys: Internal Anatomy

In the Urinary System Views section, open View 8. Kidney Section (F). Use this view to answer the following questions.

1. Select the outer part of the cross section of the right kidney and use the book icon to read the definition (Kidney back, R). Define the following terms:

   a. **Adipose capsule**  A mass of adipose tissue surrounding each kidney
   
   b. **Cortex**  The outer layer of the kidney
   
   c. **Medulla**  The inner layer of the kidney

2. Select one of the several pyramid-shaped structures on the inside of the kidney. Which structures make up the bulk of the **renal pyramids**?

   **They are made up mostly of nephrons.**
3. Where are the **renal columns** found?

*In the medulla, between the pyramids*

4. **Urine** from the pyramids is channeled into the ____*renal pelvis*____.

5. Locate the large **renal pelvis** in the center of the kidney. Urine from the renal pelvis is channeled into the ____*ureter(s)*____.

6. **Nephrons** are the functional units of the kidneys that make up most of the cortex and the medulla.
   
   a. Nephrons are composed of a series of ____*tubules*____ and ____*arterioles*____.
   
   b. The primary site of **filtration** is in a spherical capillary network called the ____*renal (Malpighian) corpuscle*____.
   
   c. Inside the corpuscle, blood passes through a spherical capillary network called the ____*glomerulus*____.
   
   d. **Filtrate** from the blood enters a cavity called the ____*glomerular (Bowman’s) capsule*____. From there, the filtrate is passed through the **tubules** until it enters the renal pelvis as urine.
C. The Ureters and the Bladder

In the Urinary System Views section, select View 11. Ureters (M). Use this view to answer the following questions.

1. Select either of the ureters and use the book icon to read the definition.

   a. What is the function of the ureters?

      **To deliver urine to the bladder**
b. How is urine propelled through the ureters?

*By contraction of smooth muscle (in the ureter walls)*

c. How long is each ureter?

*25–30 cm*

2. In the system tray on the left side of the screen, deselect the skeleton system icon to hide the skeletal structures from the view. Rotate the view and observe where the ureters enter the bladder. The ureters enter the bladder through openings in the ____rear (posterior, dorsal, or posterolateral)____ bladder floor.

3. In the system tray on the left side of the screen, deselect the muscular system icon to hide the muscles from the view. Rotate the bladder for a posterior view, showing both ureters. The triangular region of the bladder, marked by the entrance of the two ureters and the *external urethral orifice*, is the ____trigone____ of the bladder.
Go back to the Urinary System Views and open View 14. Bladder (F). Note that the bladder is located entirely inside the pelvis, protected by the pelvic bones. Select any part of the bladder, use the book icon to read the definition, and answer the following questions.

1. The **bladder mucosa** is covered by a _____transitional_____ epithelium and is arranged in folds called _____rugae_____.

2. A layer of smooth muscle, called the _____detrusor muscle_____, gives the bladder wall its elasticity.

3. Approximately how much urine can the bladder hold before the urge to micturate is triggered? **500 ml**
Go back to the Urinary System Views and open View 17. Bladder Section (M). Locate the following structures in the cross-section view.

1. Bladder inner surface
2. Detrusor muscle layer
3. Neck of the bladder (the region joining the urethra)
D. The Male Urethra

In the Urinary System Views, select View 21. Urethral Orifice (M). Use this view to answer the following questions.

1. Select any part of the urethra and use the book icon to read the definition. Locate and name the three portions of the male urethra.
   - **Prostatic, membranous, and cavernous (spongy)**

2. The **prostatic urethra** is completely within the ____prostate (gland)____.

3. In the **prostate**, the urethra is joined by paired ____ejaculatory____ ducts.

4. The **membranous urethra** passes through the ____urogenital diaphragm____ and receives ducts from the paired ____bulbourethral (Cowper’s)____ glands.
5. Select the **corpus spongiosum** and use the Hide tool in the content box to hide it. Select the **spongy urethra** and rotate the view to observe where it exits the penis. Note that only half of the urethra will be highlighted. Next, select the **glans penis** and use the Hide tool in the content box to hide it, so you can view the end of the spongy urethra. Note how it expands slightly in the tip of the penis. The spongy portion of the urethra is divided into two sections: the **bulbar** section and the **pendulous** section.

6. The male urethra carries two products: **urine** and **semen**.

**Go back to the Urinary System Views and open View 23. Urethral Sphincter (M). Use this view to answer the following questions.**
1. Locate and highlight the **internal urethral sphincter**. It controls the passage of urine from the bladder into the urethra. Control of this sphincter is involuntary, and it opens when the volume of urine in the bladder triggers the ____**micturition**____ reflex.

2. A second, **voluntary external urethral sphincter** encircles the ____**membranous**____ urethra. This muscle allows for voluntary control over micturition.
E. The Female Urethra

In the Urinary System Views, select View 20. Bladder and Uterus (F). Note that the bladder is located entirely within the pelvis under the uterus. Use this view to answer the following questions.
1. Locate and select the urethra. It passes through the ____perineum____ and exits through the ____vulva____. With the urethra highlighted, rotate the view to observe where it exits the vulva. It is very small, so you may need to zoom in.

2. Locate the **urethral orifice**, which surrounds the end of the urethra. Select it and use the book icon to read the definition. The urethral orifice is contained inside the ____vestibule____, directly in front of the opening of the ____vagina____.
Go back to the Urinary System Views and open View 24. Urethral Sphincters (F). Use this view to answer the following questions.

1. Select the neck of the bladder, where it joins the urethra. Now, hide the neck and locate the **internal urethral sphincter**. This involuntary sphincter opens during the **micturition** reflex.

2. Locate the **external urethral sphincter**. This muscle allows for **voluntary** control over micturition.
G. Microanatomy: Nephrons

From the Views menu, select Microanatomy, scroll down, and open View 19. Nephrons.

Cortex
Interlobular arteries
Arcuate arteries
Renal pyramids
Renal column

Interlobar artery
Segmental arteries

Proximal convoluted tubule
Cortex
Interlobar veins
Descending limb of loop of Henle
Arcuate veins

Peritubular capillaries
Glomerular capsule
Nephrons
Efferent arteriole
Afferent arteriole

Ascending limb of loop of Henle
Collecting duct
Vasa recta
1. Locate the cortex, the renal pyramids, and the renal columns of the medulla.

2. Locate the renal artery as it enters the kidney (it does not enter the renal pelvis as the diagram suggests). The first branches of this artery that are located inside the kidney are the segmental arteries and these extend into the renal columns as interlobar arteries. The branches that arc over each pyramid are called arcuate arteries, and smaller branches called interlobular arteries extend further into the cortex. These arteries supply the nephrons.

3. Locate and select the large, light-colored tubule passing through the renal pyramid. In the content box, select the arrow and choose Nephrons at the top. This will highlight all nephron structures. There are three nephrons in this view, but there are approximately one million of them in each kidney. Nephrons are complex structures that include a capsule, tubules, and associated blood vessels.

4. Locate the small, spherical glomerular capsule in the center nephron, at the top of the image. Select this capsule and use the book icon to read the definition. Inside the capsule, you’ll see a spherical capillary network called a glomerulus. High blood pressure in these specialized capillaries forces fluid out of the blood vessels and into the capsular space. This fluid, called filtrate because it has been filtered by the glomerulus, leaves the capsule and enters the proximal convoluted tubule. As the tubule travels down into the medullary pyramid, it is called the descending limb of the loop of Henle and as it travels back up into the cortex, it is called the ascending limb of the loop of Henle. As the filtrate passes through the loop of Henle (also called a nephron loop), it is modified by the loop’s epithelium. These epithelial cells are cuboidal in shape and have a “brush border,” meaning they are covered with microvilli. As the tubule exits the medulla, it is called the distal convoluted tubule. As the tubule straightens out again and exits via the renal pyramid, it is called a collecting duct.

5. As filtrate travels through the nephron loop, the tubule cells secrete waste and excess ions into the filtrate. As the loop travels down into the medulla and back, it passes through salt gradients that facilitate the reabsorption of water and other necessary molecules as required.

6. When these processes are complete, the filtrate is called urine. Fluid from the collecting duct flows into the renal pelvis.
7. Locate the arteriole entering the capsule to form the glomerulus. It is called the _afferent arteriole_. The arteriole exiting the capsule, coming from the glomerulus, is the _efferent arteriole_. This arteriole branches into a network of _peritubular capillaries_ that surround the proximal and distal convoluted tubules. These capillaries interact with the convoluted tubules to reabsorb water and adjust the concentrations of solutes in the filtrate. Blood leaving the _peritubular capillaries_ enters the _interlobular_ veins, which join the _arcuate_ veins that arc over the pyramids. The arcuate veins join to become the _interlobar_ veins in the renal columns. These join the _renal_ veins, which take blood out of the kidneys to drain into the _inferior vena cava_.

8. Look at the nephron on the right side of the view. It has a much longer loop of Henle, extending much further into the medulla, than the one in the center. The center nephron is called a _cortical nephron_. The one on the right is a _juxtamedullary nephron_, as its capsule is adjacent to the medulla. Approximately 20–30% of nephrons are juxtamedullary nephrons, which are responsible for creating most of the physiological gradients in the kidney. To help create these gradients, there are a series of capillaries, branching from the peritubular capillaries and associated with the loop of Henle, collectively called the _vasa recta_. This network returns blood to the efferent end of the peritubular capillaries and to the interlobular veins.
PUTTING IT ALL TOGETHER

A. Draw an outline of the urinary system. Label each organ and use arrows to indicate the flow of urine.

B. Answer the following questions:

1. Look at Views 21. Urethra and Orifice (M) and 22. Urethra and Orifice (F). What are the main differences between the male and female urinary systems?

   The male’s urethra is much longer than the female’s, and it serves as the conduit for semen. In females, the urinary system and the reproductive system are separate.

2. Look at Views 23. Urethral Sphincter (M) and 24. Urethral Sphincters (F). Which structure gives us voluntary control over micturition?

   The external urinary sphincter

3. In View 1. Urinary System (M), select one of the kidneys, use the up-arrow in the content box to choose Urinary System from the list, and use the book icon to read the definition. Which of the following do you think is not a function of the kidney?

   a. Removal of waste product from the body
   b. Control of micturition
   c. Regulation of electrolyte balance (e.g. sodium, potassium, and calcium)
   d. Regulation of acid-base homeostasis
   e. Controlling blood volume and maintaining blood pressure

TIME TO PRACTICE!
GO TO THE URINARY SYSTEM QUIZZES AND TAKE QUIZ 1 OVERVIEW, URINARY (M), QUIZ 2 OVERVIEW, URINARY (F), QUIZ 3 KIDNEYS, QUIZ 4 URINARY & REPRO (M), AND QUIZ 5 URINARY & REPRO (F).
Student Practice

Label the structures in the following figures.
Source: Urinary System Views: View 1. Urinary System (M)
Source: Urinary System Views: View 2. Urinary System (F)
Source: Urinary System Views: View 3. Pelvic Region (M)
Source: Urinary System Views: View 4. Pelvic Region (F) (Part 1)
Source: Urinary System Views: View 4. Pelvic Region (F) (Part 2)

- Kidney
- Ureter
- Uterus
- Bladder
- Rectum
- Urethra
- Pelvic floor
Source: Urinary System Views: View 8. Kidney Section (F)
Kidneys

Entrance of left ureter

Trigone

Entrance of right ureter

Bladder

Prostate

Source: Urinary System Views: View 11. Ureters (M)
Source: Urinary System Views: View 14. Bladder Section (F)
Prostate
Bladder neck
Detrusor muscle
Bladder inner surface
Prostate

Source: Urinary System Views: View 17. Bladder Section (M)
Ureters
Prostatic urethra
Ejaculatory duct
Membranous urethra
Bladder
Spongy urethra
Corpus spongiosum
Glans penis

Source: Urinary System Views: View 23. Urethral Sphincter (M)
Urethra
Vestibule
Uterus
Bladder
Perineal membrane
Urethral orifice

Source: Urinary System Views: View 20. Bladder and Uterus (F) (Part 2)
Source: Urinary System Views: View 24. Urethral Sphincters (F)
Cortex

Interlobular arteries

Arcuate arteries

Renal pyramids

Renal column

Interlobar artery

Segmental arteries

Nephrons