

# Exercise 10: The Urinary System

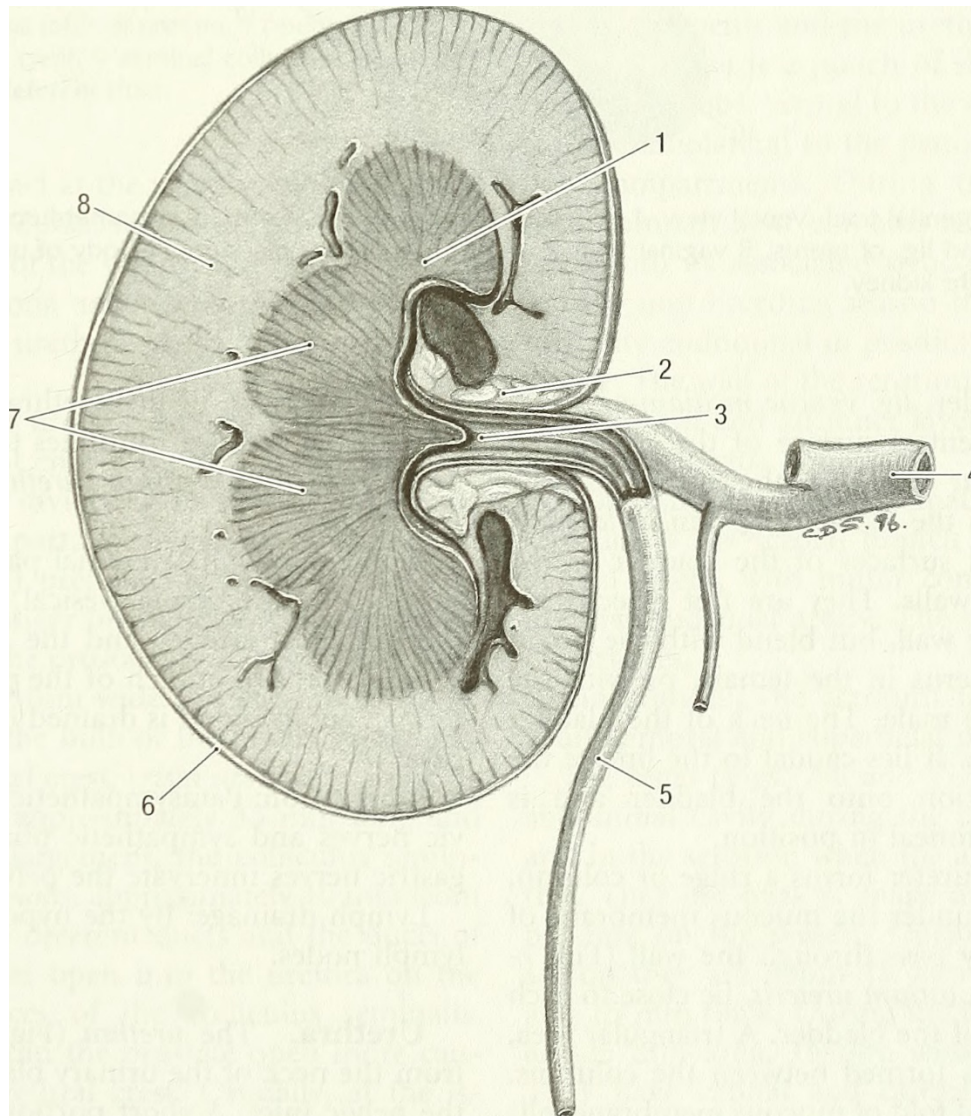


Figure 10.1. Illustration of a woodchuck kidney from an anterior view and highlighting the internal anatomy of the kidney.

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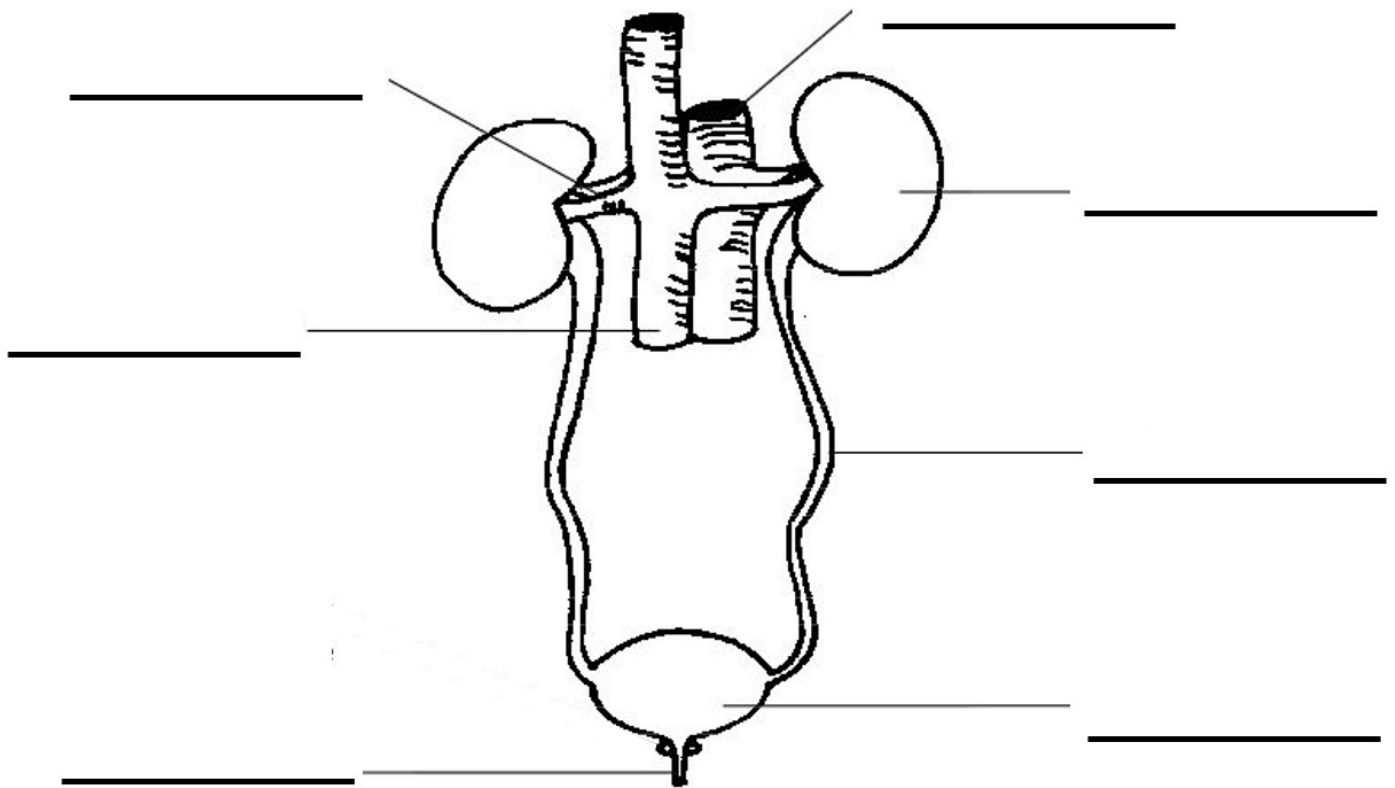
## Exercise 10 Learning Goals

After completing this lab, you should be able to:

- Label structures of the urinary system
- Characterize the roles of each of the parts of the urinary system
- Illustrate the macroscopic and microscopic structures of the kidney
- Outline how blood is filtered in the kidney nephron

**Pre-Lab Activity 10.1** Identify the major organs of the urinary system and their relation to major abdominal blood vessels

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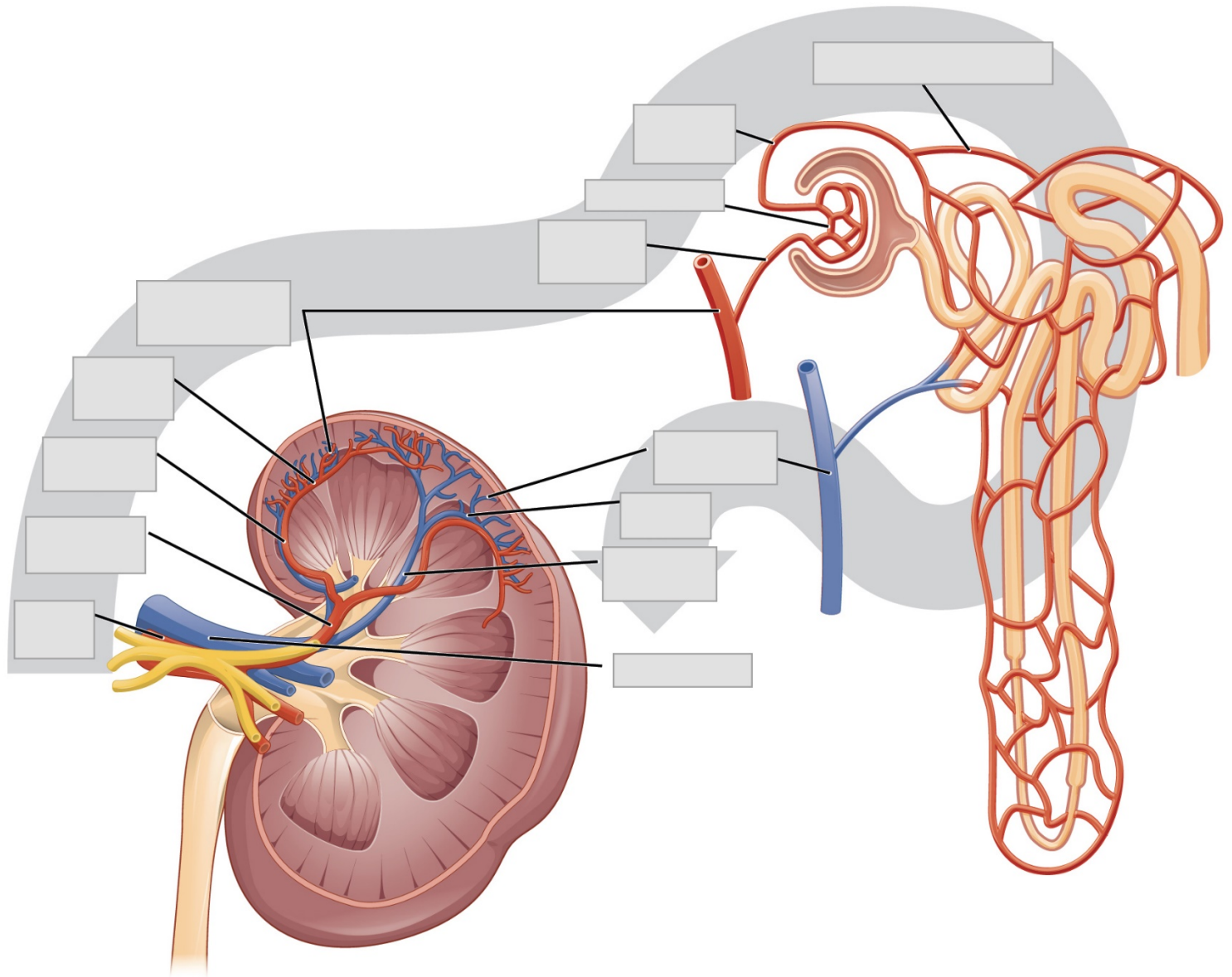


Which of these organs are responsible for PRODUCING urine?

Which structures/organs are responsible for **STORING** urine?

Why do the kidneys receive such direct and major blood flow to/from them? How does their location relative to major blood vessels of the abdomen probably relate to their function?

**Pre-Lab Activity 10.2** Identify the key structures of the kidney and its functional unit, the nephron.



Where in the kidney are the parts of a nephron found?

What are the two different types of nephrons? What is different about them?

Where does urine production end and its removal from the kidney begin?

## Lab Exercise 10: Anatomy of the Urinary System

The urinary system's main role is to control the composition and volume of blood and keep the body in homeostasis. The body is constantly producing waste products such as ammonia, salts and excess water. High levels of any of these products in the blood can be damaging to our organs. Therefore, it is important to filter the blood and remove any excess waste products.

This is the main role of the **urinary system**.

This system is made up of the following organs and associated structures: **kidneys; ureters; urinary bladder; urethra**. Figure 10.2 shows how these organs are connected within a child's urinary system.

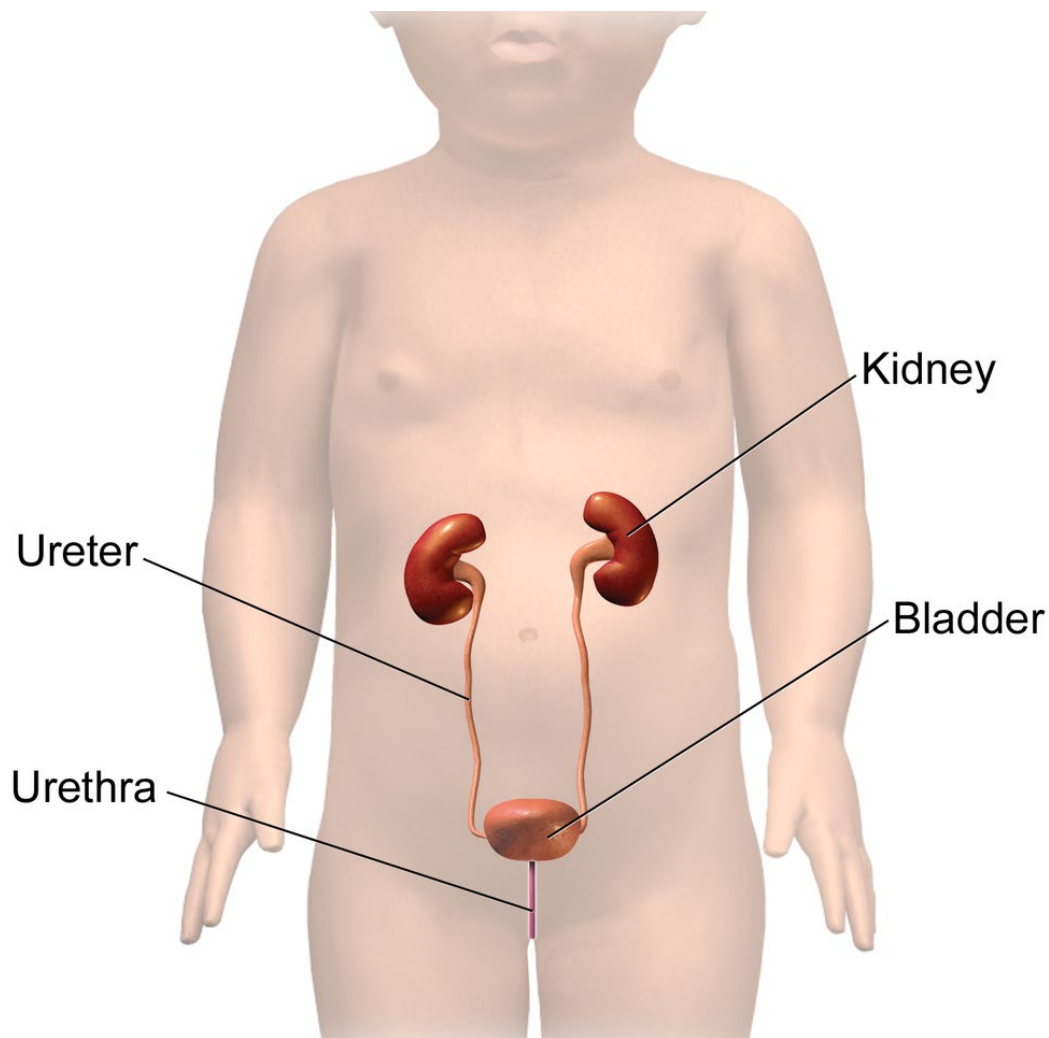


Figure 10.2. Child's urinary system

([https://commons.wikimedia.org/wiki/Category:Human\\_urinary\\_system#/media/File:Urinary\\_System\\_\(Child\).png](https://commons.wikimedia.org/wiki/Category:Human_urinary_system#/media/File:Urinary_System_(Child).png))

## Kidneys

For this lab, of all the organs in the urinary system, it is the kidney that is of most importance. The kidneys are **retroperitoneal**, which means they technically are situated outside of the peritoneal cavity and are found adhered to the posterior abdominal wall. The left kidney is located around T12-L3 whereas the right is slightly lower due to the placement of the liver. The kidneys are covered by connective tissue called the **renal capsule**.

The macro internal anatomy of the kidney is represented in figure 9.3. The outer region of the kidney is known as the **cortex**. This is a highly vascularized and important area where the functional unit of the kidney is found, the **nephron** (see below). The area deep to the cortex is known as the **medulla**. The medulla includes the cone shaped structures called **pyramids**, and the area that separates the individual pyramids are called **renal columns**. Blood is filtered through the pyramids where the waste (in the form of urine) passes through the **papilla**, before being collected at the **renal pelvis**. Urine drains from the pyramids into the pelvis via **major and minor calyces**. Minor calyces are directly connected to individual pyramids at the papilla. Urine drains from these minor calyces into larger major calyces before being collected at the pelvis and continuing into the **ureter**. The ureter transports the urine to the **bladder**, where it is eventually expelled through the **urethra** (figure 9.2).

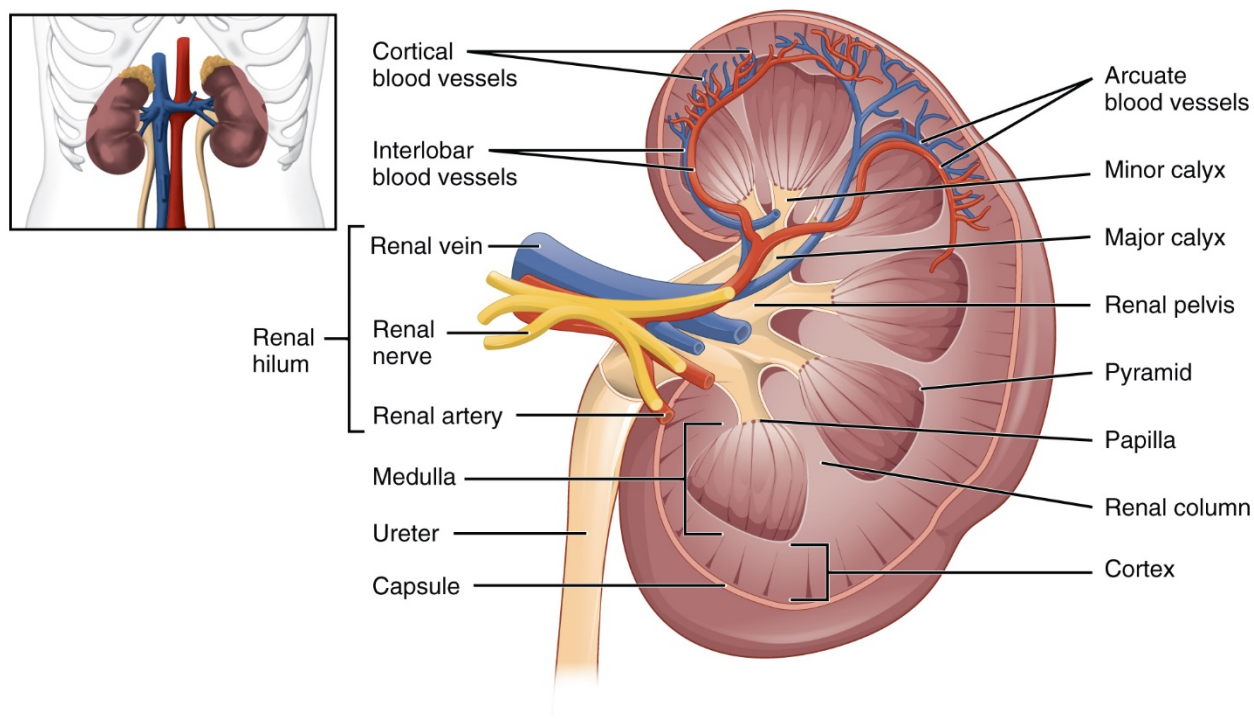


Figure 10.3. Internal anatomy of the left kidney (<http://cnx.org/contents/14fb4ad7-39a1-4eee-ab6e-3ef2482e3e22@15.5.>)



## The Nephron

The best way to understand how blood is filtered is to learn blood circulation through the kidneys. The **renal hilum** is the site where the two major blood vessels, the **renal vein** and **renal artery**, along with the **renal nerve**, exit and enter the kidney (figure 9.3). The hilum is also where the renal pelvis forms the ureter, before exiting the kidney.

The renal artery, carrying nutrients and waste products, enters the kidney and branches towards the cortex via the renal columns. Within the cortex, the branching artery (now called arterioles) surround millions of nephrons (figure 10.4). An afferent arteriole forms a convoluted structure of capillaries called a **glomerulus**. Due to the blood being at a high pressure at the glomerulus, important molecules such as proteins, glucose, salts and water, along with waste products that need disposed of, get removed here. They get collected in a structure called **Bowman's capsule** (glomerular capsule in figure 9.4) and flow through the different parts of the nephron towards the collecting duct, that eventually leads to the ureter. Molecules that are important for the everyday function of the body such as glucose get reabsorbed into the blood at the loop of the nephron (**loop of Henle**; figure 9.4).

What substances are secreted/absorbed in the various parts of the nephron?

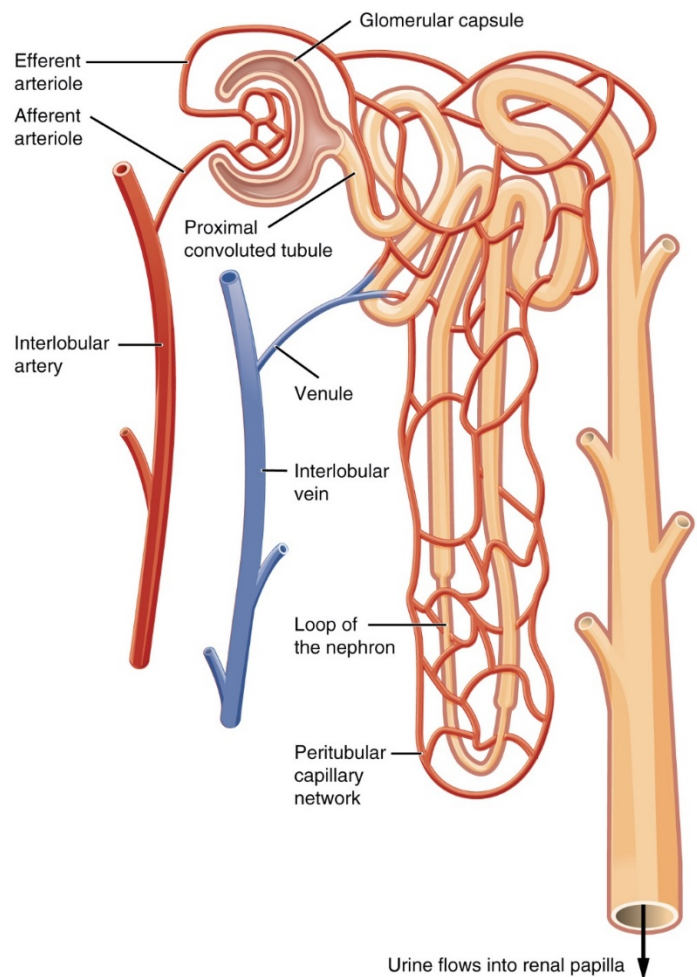


Figure 10.4. Blood vessels surrounding an individual nephron

## Lab Activity 10.1: Fetal Pig Urinary System Dissection

Supplies needed: Gloves, scalpel/scissors, blunt probe, tweezers

Use human terminology where ever terms for the pig may differ.

### Structures to Identify:

Fetal Pig	Pig/Sheep Kidney
<input type="checkbox"/> Adrenal glands (R & L)	<input type="checkbox"/> Arcuate blood vessels
<input type="checkbox"/> Bladder	<input type="checkbox"/> Interlobar blood vessels
<input type="checkbox"/> Kidneys (R & L)	<input type="checkbox"/> Interlobular blood vessels
<input type="checkbox"/> Renal artery and vein (R & L)	<input type="checkbox"/> Renal calyces (minor & major)
<input type="checkbox"/> Ureters (R & L)	<input type="checkbox"/> Renal columns (structure)
<input type="checkbox"/> Urethra	<input type="checkbox"/> Renal cortex (tissue)
	<input type="checkbox"/> Renal medulla (tissue)
	<input type="checkbox"/> Renal papillae
	<input type="checkbox"/> Renal pelvis
	<input type="checkbox"/> Renal pyramids (structure)

### For the fetal pig urinary system:

1. To begin, locate the two **kidneys** in the abdominal cavity. Find the **adrenal (suprarenal) glands**: small, white bands of tissue on the top, inside edge of each kidney. Be aware that the peritoneum holds the adrenal gland against the kidney; because you may have removed the peritoneum during previous dissections, the adrenal will no longer be resting on the kidney but will instead be near the spinal column. Also, although there are left and right adrenal glands, often the left adrenal is missing due to the removal of tissue during the dissection of the posterior blood vessels earlier in the semester.
2. Observe and trace the **ureters** from their origin at the **hilum** of each kidney. These are the bilateral tubes that go from each kidney to the **urinary bladder**. The bladder is the muscular structure located between the two umbilical arteries. Remember that the bladder is not filled with urine in your pig, so it does not have the shape you may be expecting.
3. Locate the **urethra** coming off the base of the bladder. You will get a much better view of the urethra after you have completed the dissection of the reproductive systems. Note that the female urethra is short while the male urethra is many times longer.

## Lab Activity 10.2: Sheep Kidney / Dyed Pig Kidney Observation

1. Obtain one undyed sheep kidney from those provided. If uncut- make a longitudinal incision through the kidney.
2. Observe the **renal capsule**, the thin membranous covering of the kidney.
3. The **renal pelvis** is the large sac at the base of the kidney. It may be filled with white adipose tissue.
4. The **pyramids** are the smooth, discolored structures located in the inner core of the kidney, above the pelvis.
5. The **calyces** are the tube-like extensions from the renal pelvis. The pin-prick openings at the ends of the calyces are the **papillae**. The **columns** are the tissue between each calyx.
6. The **renal medulla** is the tissue of the pyramids.
7. The **renal cortex** is the tissue of the columns and tissue between the pyramids and renal capsule.

For blood vessels, obtain a dyed kidney half:

8. The **arcuate blood vessels** run between the pyramids and cortex. The **interlobar vessels** run in the columns between pyramids (lobes). The **interlobular vessels** are in the cortex between the pyramids and capsule.

After dissecting your specimens, answer the following questions:

1. What is the function of the renal capsule?
2. Which structure is continuous with the renal pelvis that transport waste from the kidneys to the bladder?
3. What is the structural importance of the renal hilum?
4. What is the difference between calyces and papillae?



5. Where in the kidneys are nephrons present?
6. What is the importance of the arcuate blood vessels?
7. Why is the loop of Henle so long?