29 Anatomy of the Urinary System

Answers to Pre-Lab Assignments

Pre-Lab Activity 1:

1. a. renal cortex
   b. renal medulla
   c. renal capsule
   d. renal pelvis
   e. renal artery
   f. renal vein
   g. ureter

2. 1. e
   2. c
   3. f
   4. b
   5. d
   6. g
   7. a
   8. h

Pre-Lab Activity 2:

1. frontal; anterior and posterior
2. indention on the medial surface; renal artery, renal vein, ureter

Pre-Lab Activity 3:

1. glomerulus, glomerular capsule
2. visceral, parietal, capsular
3. c

Answers to Activity Questions

Activity 1

<table>
<thead>
<tr>
<th>Structure</th>
<th>Description/Function</th>
<th>Connections to Things I Have Already Learned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Renal capsule</td>
<td>Outermost CT wrapping of kidney</td>
<td>Other organs such as a lymph node and the spleen also have capsules.</td>
</tr>
<tr>
<td>Renal cortex</td>
<td>Outer region of kidney</td>
<td>Adrenal gland and lymph node also have cortical regions.</td>
</tr>
<tr>
<td>Renal medulla</td>
<td>Region of the kidney deep to the cortex</td>
<td>Adrenal gland and lymph node also have medullary regions.</td>
</tr>
<tr>
<td>Term</td>
<td>Description</td>
<td>Additional Information</td>
</tr>
<tr>
<td>---------------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Renal column</td>
<td>Cortical tissue that dips down into medullary region</td>
<td>Renal columns are similar to extensions of the lymph node capsule called trabeculae that divide the lymph node into compartments.</td>
</tr>
<tr>
<td>Renal pyramid</td>
<td>Contains nephron loops, collecting, ducts, and vasa recta</td>
<td>Papilla (apex) means pointed; papilla points inward toward minor calyx.</td>
</tr>
<tr>
<td>Renal pelvis</td>
<td>Kidney region that collects urine and directs it to the ureter</td>
<td>Major calyces converge to form renal pelvis.</td>
</tr>
<tr>
<td>Minor calyx</td>
<td>Small cavity that receives urine from the collecting duct</td>
<td>Contraction of smooth muscle cells in calyces propel urine toward the renal pelvis.</td>
</tr>
<tr>
<td>Major calyx</td>
<td>Large cavity that receives urine from the minor calyx</td>
<td>Contraction of smooth muscle cells in calyces propel urine toward the renal pelvis.</td>
</tr>
<tr>
<td>Renal corpuscle</td>
<td>Consists of glomerulus and glomerular capsule – filters blood</td>
<td></td>
</tr>
<tr>
<td>Glomerular capsule</td>
<td>C-shaped structure with outer parietal layer and inner visceral layer</td>
<td>Inner visceral layer contains podocytes with foot-like processes (pedicels) that interdigitate to form filtration slits.</td>
</tr>
<tr>
<td>Glomerulus</td>
<td>Specialized blood capillary; filtration</td>
<td>Contains pores called fenestrations; along with visceral layer of glomerular capsule, forms the filtration membrane.</td>
</tr>
<tr>
<td>Renal tubule</td>
<td>Proximal tubule, nephron loop, and distal tubule.</td>
<td></td>
</tr>
<tr>
<td>Proximal tubule</td>
<td>Region of tubule nearest to the glomerulus.</td>
<td>Composed of simple cuboidal epithelium; cells contain many microvilli.</td>
</tr>
<tr>
<td>Nephron</td>
<td>Region of tubule</td>
<td>Composed of simple squamous epithelium and</td>
</tr>
<tr>
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<td>-------------------</td>
<td>--------------------------------------------------------------------------------------</td>
<td>---------------------------------------------</td>
</tr>
<tr>
<td>Peritubular capillaries</td>
<td>Capillaries that surround cortical nephrons; provide blood supply</td>
<td>Peri = around</td>
</tr>
<tr>
<td>Vasa recta</td>
<td>Capillary associated with the nephron loop of juxtamedullary nephron</td>
<td>Recta = straight</td>
</tr>
<tr>
<td>Renal artery</td>
<td>Transports oxygenated blood to kidney.</td>
<td>Branches from abdominal aorta.</td>
</tr>
<tr>
<td>Afferent arteriole</td>
<td>Transports blood to the glomerulus.</td>
<td>Afferent neurons carry impulse toward the CNS.</td>
</tr>
<tr>
<td>Glomerulus</td>
<td>Specialized blood capillary; filtration</td>
<td>Glomerulus = ball; adrenal cortex has layer called zona glomerulosa (produces aldosterone).</td>
</tr>
<tr>
<td>Efferent arteriole</td>
<td>Transports blood away from glomerulus.</td>
<td>Efferent neuron transmits impulse away for CNS to the effector.</td>
</tr>
</tbody>
</table>

**Loop**

- that forms hairpin loop; sets up interstitial concentration gradient.

**Distal tubule**

- Receives filtrate from the nephron loop; filtrate then travels to the collecting duct.

**Collecting duct**

- Receives filtrate from many nephrons; reabsorbs water to concentrate urine.

**Cells contain aquaporins (water channels); ADH stimulates insertion of aquaporins in cell membrane of cells lining the collecting duct.**

**Renal artery**

- Transports oxygenated blood to kidney.

**Afferent arteriole**

- Transports blood to the glomerulus.

**Efferent arteriole**

- Transports blood away from glomerulus.

**Glomerulus**

- Specialized blood capillary; filtration

**Connections to Things I Have Already Learned**

- Peri = around
- Recta = straight
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<tr>
<th>Structure</th>
<th>Function</th>
<th>Adaptation</th>
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<tr>
<td>Renal vein</td>
<td>Transports deoxygenated blood away from kidney.</td>
<td>Empties into the inferior vena cava.</td>
</tr>
<tr>
<td>Ureter</td>
<td>Transports urine from kidney to urinary bladder.</td>
<td>Wall has three layers: inner epithelium, middle layer of smooth muscle, and outer layer of connective tissue.</td>
</tr>
<tr>
<td>Urinary bladder</td>
<td>Stores urine; muscular sac.</td>
<td>Inner lining composed of transitional epithelium; hollow organ—contains smooth muscle layer.</td>
</tr>
<tr>
<td>Urethra</td>
<td>Transports urine out of the body in females; transports urine and sperm out of the body in males.</td>
<td>Mucous membrane – opens to the exterior of the body.</td>
</tr>
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</table>

Activity 2
4. What is the function of the renal capsule? _protects the kidney from infection_
5. State the function of each of these structures, and describe one way in which each is structurally adapted to its function.
   - renal artery: _transports oxygenated blood to kidney; thick muscular wall for higher blood pressure_
   - renal vein: _transports deoxygenated blood away from kidney; veins contain valves to prevent backflow of blood_
   - ureter: _transports urine from kidney to urinary bladder; thick muscular wall aids in transport of urine via peristalsis_

Activity 3
1. Kidney
   b. What is the function of these microvilli? _increases surface area for reabsorption in the proximal tubules_
2. Renal Corpuscle
   a. On which structure do the podocytes sit? _glomerulus_
   b. Which structure leads into the glomerulus? _afferent arteriole_
   c. Which structure extends from the glomerulus? _efferent arteriole_
   c. How are these two structures different? _Afferent arteriole is larger in diameter than the efferent arteriole._

Predict a physiological consequence of this difference. _Blood flows into glomerulus faster than it flows out resulting in increased blood pressure in the glomerulus._
3. Urinary Bladder
   a. mucosa ___transitional epithelium___
      muscularis ___smooth muscle___
   b. Which epithelial cell shapes are visible in the transitional epithelium? ___squamous, cuboidal, columnar, and dome-shaped___
      What unique ability do these cells of the transitional epithelium possess? ___ability to stretch___
      Why are the apical cells sometimes flat and sometimes dome shaped? If bladder is full, they are ___flat. If bladder is empty, they are dome-shaped.___
2. Which urinary organ:
   a. produces urine? **kidney**
   b. transports urine out of the body? **urethra**
   c. stores urine? **urinary bladder**
   d. transports urine from the kidney to the bladder? **ureter**

Activity 2: Dissecting a Mammalian Kidney
1. Which connective tissue wrapping:
   - **renal capsule** a. protects the kidney from infection?
   - **adipose capsule** b. cushions the kidney?

2. Which kidney structure:
   - **renal cortex** a. houses the renal corpuscles?
   - **renal pelvis** b. is continuous with the ureter?
   - **renal column** c. separates renal pyramids?
   - **minor calyx** d. collects urine as it drains from a papilla?

Activity 3: Examining the Microscopic Anatomy of the Kidney, Ureter, and Urinary Bladder
1. Label the structures indicated in the following microscopic view of a kidney.
   a. **Visceral layer of glomerular capsule/glomerulus**
2. The inner visceral layer of the glomerular capsule is composed of cells called **podocytes**. These cells have foot-like processes called **pedicels** that interdigitate to form **filtration slits**. The visceral layer of the glomerular capsule lies on top of the glomerulus, which is studded with pores called **fenestrations**. Collectively, the inner visceral layer of the glomerular capsule and the glomerulus comprise the **filtration** membrane.

3. Label the structures indicated in the following microscopic view of the urinary bladder.
   a. **transitional epithelium**
   b. **basement membrane**
   c. **connective tissue**
Part II. Putting It All Together

A. Review Questions

Answer the following questions using your lecture notes, your textbook, and your lab notes.

1. List the connective tissue wrappings surrounding the kidney from the deepest to the most superficial wrapping.

   *renal capsule, adipose capsule, renal fascia*

2. Trace the pathway of blood from the left ventricle to the glomerulus.

   *LV → ascending aorta → aortic arch → descending thoracic aorta → descending abdominal aorta → renal a. → segmental a. interlobar a. → arcuate a. → interlobular a. → afferent arteriole → glomerulus*

3. What is the physiological consequence of the afferent arteriole being larger in diameter than the efferent arteriole?

   *Hydrostatic pressure builds up in the glomerulus, thus facilitating pressure filtration.*

4. How is the specialized epithelium of the urinary bladder related to its function?

   *Transitional epithelium has the unique ability to stretch as the bladder fills with urine.*