In beginning a laboratory study of the histology of the kidney there are some advantages to studying the kidney of a rat or rabbit in addition to that of the human. This is because the basic unit of gross structure of the kidney is the **lobe**. Whereas the kidney of the rat or rabbit consists of only one lobe (unilobar) that of the human consists of many lobes (6-16), i.e., it is multilobar. Furthermore, the kidney of the rat or rabbit is much smaller, hence a full-length section of the organ can fit on a slide, and all parts of a lobe as well as its connections with the ureter can be seen. In contrast, because the human kidney is much larger and multilobar, any one section shows only a small part of it, and generally incomplete parts of more than one lobe. Hence, the section is more difficult to interpret.
A renal lobule is defined by one collecting duct (black) and includes all the nephrons, which ultimately drain into it. That collecting duct runs in a medullary ray in close parallel association with the loops of Henley of its associated nephrons. Consequently the medullary ray marks the center of the lobule. (Keep in mind that medullary rays and renal lobules are features of the renal cortex). The interlobular arteries tend to be located midway between two medullary rays, so they are found near the lateral margins of the lobules. However, the interlobular arteries DO NOT define the lateral margins of the lobule.

The medulla is subdivided into **renal pyramids**, each along with overlying cortex the basic unit of a **renal lobe**. The base of the pyramid is contiguous with the cortex; the apex is oriented toward the pelvis and projects into a **minor calyx**. Note how the cortex extends down around the sides of the pyramid. These cortical extensions between pyramids are denoted as the **renal columns** (of Bertin).

In the hilar region, note how the minor calyx cups around the apex (**papilla**) of a pyramid. You may see **papillary ducts** (of Bellini) opening into the calyx at the papillary apex (**area cribrosa**). Examine the histology of the wall of calyx. What is the functional significance of urothelium (poorly preserved in this slide) and underlying smooth
muscle? Observe the white adipose tissue that fills the surrounding **renal sinus**. Identify the **renal artery**, **vein** and **associated nerves**.

Referring to the drawings below, trace the parts of the **renal vascular system**. Locate following vessels: (a) **interlobar**, between adjacent pyramids, (b) **arcuate**, at corticomedullary boundary, (c) **interlobular**, midway between neighboring medullary rays, (d) **afferent and efferent arterioles** of the renal corpuscles, which usually cannot be differentiated from each other with ease, and (e) the **capillary plexuses** which surround tubules in the cortex and medulla and are fed respectively by the efferent glomerular arteriole and the **vasa recta**. The arteries are accompanied by corresponding veins.

Tubular system.
The renal corpuscles consist of a **glomerulus** and a **capsule** (of Bowman). The **parietal epithelial** layer of the glomerular capsule is comprised of simple squamous epithelium encasing the glomerular capillaries and visceral epithelium (see figure).

The visceral epithelium is comprised of podocytes, which are separated from one another by filtration slits. There is a thick basement membrane between the capillary endothelium and the podocytes. The mesangial cells also exist in this space. They are phagocytic and help maintain the basement membrane.

At the **vascular pole** of the renal corpuscle, the **afferent** and **efferent arterioles** of the glomerulus enter and leave (respectively). The **macula densa** is created when a segment
of distal convoluted tubule abuts the vascular pole and contacts the proximal convoluted tubule. At this location, there is a thickening of the epithelium that, together with the macula densa makes the **juxtaglomerular apparatus** (JG cells, extraglomerular mesangium).

The urinary pole of the renal corpuscle is the location of origin of the proximal convoluted tubule. This tubule, which is comprised of cuboidal epithelium with a brush border, is continuous with the parietal epithelium of the renal corpuscle.
Note the location of particular tubular elements in relation to the cortex, outer medulla and inner medulla:

![Schematic representation of nephron.](image)

**The Tubular System.**

The renal or uriniferous tubule is subdivided into a secretory portion, the nephron and the collecting tubule. Before attempting to study the tubule, study the illustration on the left (and those in your atlas or textbook) and try to visualize the location of each part within the topographical areas of the kidney as they have been described.

**Calices, Pelvis and Ureter:**

The ducts that open onto the papilla discharge into minor calices. These aggregate into major calices and then to the renal pelvis in the hilar region of the kidney. This entire system is lined with urothelium.

The **ureter** is very distensible. In the undistended ureter the mucosa tends to be thown into folds. Note that the ureter has a lamina propria, but no submucosa. The muscularis (all smooth muscle) is extensive and interlaced with connective tissue, and the orientation of the muscle bundles is rather haphazard. In general, there tends to be an inner longitudinal and an outer circular layer. The ureter has an adventitial outermost layer.
The urinary bladder has a lamina propria (dense inner and less dense outer layers), no submucosa and a thick outer muscular layer (smooth muscle) in which bundles of fibers go in all directions. The urothelium allows for distension (see the figure).

**Diagrams of the luminal surface of urothelial cells in the bladder.** The upper drawing is the surface of a distended bladder; the lower drawing is that of a relaxed bladder. The plasma membrane is thickened to form plaques. In the relaxed bladder the plaques are invaginated into the cell, thus reducing the size of the lumen of the bladder. In the distended bladder the plaques are smooth and part of the surface increasing the capacity of the bladder lumen.
CHECK LIST

KIDNEY: Understand the basic concept of the renal lobe at the gross and microscope level, including the vascular branches that contribute to the architecture of a renal lobe. In addition, be able to define:

- cortex
- medulla
- medullary pyramid
- renal papilla and papillary ducts (of Bellini)
- renal columns (of Bertin)
- area cribrosa
- interlobar artery
- arcuate artery
- intralobular artery
- afferent arteriole
- (major calyx)
- (minor calyx)

Be able to identify the tissue structures contained in a nephron. Have a general understanding of the function(s) of each morphological part.

In the cortex, be able to identify:

- medullary ray (continuous into medulla)
- cortical labyrinth
- renal corpuscle
- glomerulus
  - Bowman’s capsule: parietal layer & visceral layer
  - urinary space (filtration cavity)
  - vascular pole: afferent & efferent arterioles
  - juxtaglomerular apparatus - macula densa
  - urinary pole
  - mesangial cells
  - podocytes - foot processes, slit diaphragm.
- proximal convoluted tubule - distal convoluted tubule
- collecting tubule
- EM of tubules listed above

In the medulla, be able to identify:

- descending or ascending thick limb of Henle’s loop
- thin limb of Henle’s loop
- collecting ducts
- vasa recta

URETER: Identify:

- urothelium
- terminal bars

BLADDER: Identify:

- distended urothelium
- relaxed urothelium
- detrusor smooth muscle layer