

LABORATORY 17 - URINARY SYSTEM - KIDNEY (first of two laboratory sessions)

OBJECTIVES: **LIGHT MICROSCOPY:** Recognize morphological features of the kidney at the macroscopic and microscopic levels including the cortex, medulla, hilus, renal sinus, renal pelvis, calyces and renal artery. Also in the microscope distinguish different regions of the cortex (pars convoluta, pars radiata) and medulla. Distinguish the different regions of nephrons and collecting ducts. Observe and distinguish the different tubules that are characteristic of each region. Distinguish the different branches of arteries and veins. Analyze the parts of the renal corpuscle. Recognize the characteristics of each component of the urinary passages including calyces, renal pelvis, ureter, bladder and urethra.

ELECTRON MICROSCOPY: Recognize each region of the uriniferous tubules; the components of the renal corpuscle and the characteristics of transitional epithelium.

ASSIGNMENT FOR TODAY'S LABORATORY

GLASS SLIDES

[SL 115](#) Kidney - general structure, not tubular details

[SL 116](#) Kidney - tubular detail

[SL 117](#) Kidney cortex - cross section

[SL 5](#) Rat kidney - mitochondrial stain

[SL 143](#) Rat kidney - lysosomes (1um plastic section, toluidine blue)

ELECTRON MICROGRAPHS

Texts: J. 19-4 to 19-8, 19-11, 19-18, 19-23

W. 16.14, 16-15, 16.17, 16.22, 16.23

POSTED ELECTRON MICROGRAPHS

#26 Renal corpuscle (SEM)

#27 Renal corpuscle

[Lab 17 Posted EMs](#)

SUPPLEMENTARY ELECTRON MICROGRAPHS

Rhodin, J. A.G., [An Atlas of Histology](#)

Copies of this text are on reserve in the HSL.

Urinary system pp. 370 - 382

KIDNEY

- A. KIDNEY - Gross Structure. Knowledge of the gross structure of the kidney is important for the interpretation of histological sections. From gross anatomy texts or J. 19-1, 19-2; W. 16.2, 16.3, determine where the following structures are located.
1. CORTEX - Outer zone of kidney, granular in appearance, some cortical tissue called renal columns lies between the medullary pyramids (J. 19-1; W. 16.2, 16.3).
 2. MEDULLA - Conically shaped structures that are striated in appearance. The cones are called medullary pyramids and the tip is the papilla (J. 19-1; 16.2, 16.3).
 3. HILUM - At the hilus the renal artery enters the kidney and the renal vein and the ureter leave. (Not on SL 115) (W. 16.3).
 4. RENAL SINUS - This space or cavity is enclosed mostly by the tissue of the kidney. The sinus contains an abundance of fat as well as the renal pelvis.
 5. RENAL PELVIS - The expanded region of the ureter. (J. 19-1; W. 16.2).
 6. CALYCES - Major and then minor calyces are formed from the renal pelvis. The minor calyces are associated with the papilla of the pyramid (J. 19-1; W. 16.2).
 7. RENAL ARTERY and its branches, interlobar, arcuate and interlobular (J. 19-2; W. 16.4). These branches also serve as landmarks in sections.
- B. KIDNEY - Microscopic Structure
1. SL 115 (W. 16.5) - This slide should be used to determine general regions of the kidney. It includes cortex and medulla and usually one or two papillae. However, this slide does not allow distinction of tubular detail. Use SL 116 to identify different types of tubules. (See B.2. below).
 - (a) Cortex - distinguish between the pars convoluta (cortical labyrinths) where the convoluted tubules and renal corpuscles are located and the pars radiata (medullary rays) containing straight portions of tubules (pars convoluta within red line, pars radiata within blue line).
 - (b) Medulla - consists of renal pyramids (junction of cortex and medulla, medulla within green line) and papillae (toward the tip of the pyramid).
 - (c) Sinus - Extensive connective tissue around pyramids and vessels. Note the abundance of adipose tissue close to calyces.
 - (d) Calyces (red arrows) - If not present, try to find renal pelvis
 - (e) Arcuate arteries and veins (1, 2, arcuate aa. within yellow circles), interlobular arteries (1, 2, blue arrows). The arcuate arteries and veins are located in the region where the cortex and medulla join. The interlobular arteries are located in the cortex within the cortical labyrinth. Find these vessels using low power.

- (f) Using your text and atlas be able to trace the pathway of blood from renal artery to renal vein naming all of the various branches (J. 19-2).
- (g) Using your text and atlas learn the structure of renal pelvis and calyces and their relationship to the renal papillae.
2. SL 116 - In this slide the various tubules may be distinguished. Preparatory to microscopic study be familiar with the location and structure of all parts of the uriniferous tubule.
- (a) Identify each successive region of the nephron and associated structures. Use the chart on the last page of this lab to help identify different regions of the tubules:
- (1) Renal corpuscle (low, med 1, med 2) including: glomerulus, parietal and visceral layers of Bowman's capsule, urinary pole (yellow arrow), and arterioles (afferent or efferent) at the vascular pole. (J. 19-9; W. 16.6, 16.9, 16.11) (arteriole, green arrow; parietal layer, red arrow; visceral layer, blue arrow).
 - (2) Proximal convoluted tubules (PCT^s) (post-mortem changes destroy much of brush border). (J. 19-13, 19-14, 19-17, 19-19; W. 16.17) Profiles of PCT^s are numerous in the pars convoluta.
 - (3) Thick descending limb (straight portion of proximal tubule). These tubules resemble the PCT^s, but the tubules are straight and located in medullary rays (enclosed within yellow lines) and in the medulla (TDL not present in this image).
 - (4) Thin segments of Henle's loops. (W. 16.20) Located in the medulla. (Disregard the discussion of collecting tubules and ducts in the legend for this micrograph.)
 - (5) Thick ascending limb (straight portion of distal tubule). This section of the nephron resembles the DCT^s. Thick ascending limbs (enclosed within blue lines) are located in the same region as the descending thick limbs.
 - (6) Distal convoluted tubes. (DCT^s) (J. 19-13, 19-14; W. 16.18). Located in the cortical labyrinth.
 - (7) Locate macula densa (1, 2, 3, enclosed by blue line,) and juxtaglomerular cells. (J. 19-20, 19-21; W. 16.19) How are they related to the nephron or the blood vessels that supply the glomerulus?
 - (8) From your notes or the text review the functions of each part of the nephron?
- (b) Collecting Ducts, - (J. 19-22; W. 16.21, 16.22, 16.24) successive regions of increasing size beginning with the connecting tubules (connecting ducts) in the pars convoluta that connect the DCT^s to the collecting ducts in the medullary rays (enclosed by blue lines). In the medulla the collecting ducts increase in diameter to become the papillary ducts in the papillary region. What are the functions of the collecting ducts?

- (c) Blood vessels - find examples of each of the various vessels. [Renal artery](#), [interlobar artery](#), [arcuate artery](#), [interlobular artery](#), [vasa recta](#), [peritubular plexus](#) and corresponding veins. All may not be apparent on one slide.
- (d) [Cortical lobule](#), - a central [medullary ray](#) ([pars radiata](#)), surrounded by [cortical labyrinth](#) ([pars convoluta](#)) and delimited from adjacent lobules by interlobular arteries ([enclosed by green line](#)). Also see [SL 117](#) and [this image from SL 117](#).
- (e) Electron micrographs -
 - (1) [Renal corpuscle](#) - micrographs illustrating low and high magnification details of ultrastructural organization in texts (J. 19-3 to 19-8, 19-10, 19-11; W. 16.13 to 16.15). Others will be posted. Learn the cell types present their relationships and their functions.
 - (2) [Tubules](#) - Distinguish between the different tubules by their ultrastructural characteristics (J. 19-15, 19-16, 19-18, 19-23; W. 16.17, 16.22). Other micrographs will be posted.
- 3. [SL 117 \(med\)](#) - Kidney cortex in cross section. Compare cortical lobules in cross section to the previous slide and identify all parts of the uriniferous tubules. What do the groups of tubules that are all cut in cross section represent?
- 4. [SL 5](#) - Rat kidney ([cortex](#), [medulla](#)) - In this slide the [mitochondria](#) are stained red. What is their distribution? How is this distribution related to function?
- 5. [SL 143](#) - Rat kidney (1 μm plastic section, toluidine blue). Although the fixation of the tissue in this slide is not ideal, [lysosomes](#) are evident within certain tubules, ([red arrows](#)). Within which tubules are the lysosomes most abundant? What is the function of the lysosomes in these tubules?

LIGHT MICROSCOPIC IDENTIFICATION OF KIDNEY TUBULES

		TUBULE	CHARACTERISTICS	LATERAL CELL MEMBRANES	CYTOPLASMIC STAINING
CORTEX					
	<i>PARS CONVOLUTA</i>	PCT	Cells large – nuclei further apart. Brush border at apex of cuboidal cells - lumen surface has irregular outline.	Not visible	Acidophilic
		DCT	Cells smaller – nuclei closer together. No brush border visible (a few microvilli are present) – cuboidal cells – lumen surface has more regular outline.	Not visible	Acidophilic
		Collecting tub. (ducts)	Cuboidal cells – no brush border (a few microvilli are present)	Visible	Most cells - Pale Acidophilia
	<i>PARS RADIATA</i>	Thick desc. limb	Resembles PCT's, but brush border less pronounced and tubules straight.	Not visible	Acidophilic
		Thick ascen. limb	Resembles DCT's, but tubules straight	Not visible	Acidophilic
		Collect. Ducts	Cuboidal cells – no brush border (a few microvilli are present)	Visible	Pale Acidophilia
MEDULLA Thick descending and thick ascending limbs and collecting ducts continue from pars radiata (medullary ray) into Medulla					
		Thin limb of loop of Henle	Simple squamous epithelium.	Usually not visible	Pale Acidophilia
		Collect. ducts become large (papillary ducts)	Cuboidal to low columnar epithelium (no brush border).	Visible	Pale Acidophilia

OBJECTIVES FOR LABORATORY 17: KIDNEY

1. Using the light microscope or digital slides, identify:

Major regions

Cortex

Pars radiata

Pars convoluta

Medulla

Pyramid

Papilla

Renal column

Hilus

Sinus

Calyces

Structures of renal tubule

Bowman's capsule

Visceral layer (podocytes)

Parietal layer

Proximal convoluted tubule

Loop of Henle

Thick descending limb

Thin limb (cannot differentiate ascending from descending)

Thick ascending limb

Distal convoluted tubule

Macula densa

Collecting (connecting) duct (tubule)

Papillary ducts

Vessels

Renal artery and vein

Interlobar artery and vein

Arcuate artery and vein

Interlobular artery and vein

Afferent arteriole

Juxtaglomerular cells

Efferent arteriole

Glomerulus

Peritubular capillary plexus

Vasa recta

2. On electron micrographs, identify:

Renal corpuscle

Glomerular capillaries (fenestrated)

Podocytes (visceral epithelium)

Foot processes (pedicels, primary and secondary)

Filtration slits (and filtration slit diaphragm)

Mesangial cells

Lamina densa

Proximal convoluted tubule / thick descending limb of loop of Henle

Thin limb of loop of Henle (cannot differentiate ascending from descending)

Distal convoluted tubule / thick ascending limb of loop of Henle

Collecting (connecting) duct (tubule)

Vasa recta