

Chapter 16

Urinary System

16.1. Introduction

The urinary system includes the: kidneys, ureters, urinary bladder, and urethra. The kidneys regulate the composition and volume of body fluids by constantly adjusting blood plasma volume and constituents that circulate through them. This regulation is accomplished by: (1) the retention of important circulating elements, (2) the excretion of certain metabolic wastes, (3) the variable retention of body water, (4) the differential regulation of salt content, and (5) and the maintenance of the acid-base balance.

The formation of urine is basically the byproduct of those continual renal processes that preserve the body's internal fluid environment against disruptive influences from the external environment. Through the regulation of the composition and the volume of circulating plasma the kidneys also will influence the immediate internal environment bathing every cell.

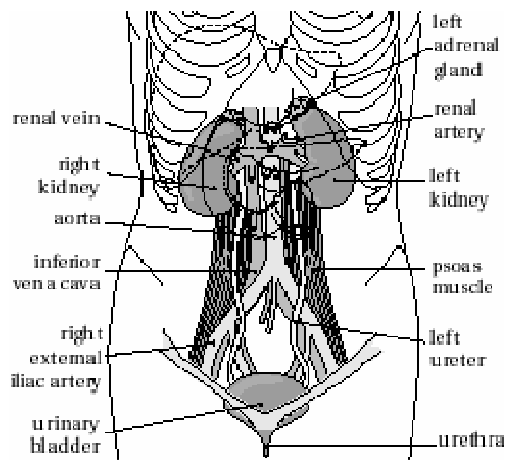


Fig. 16.1. The Structure of the Urinary System

16.2. The Kidneys

16.2.1. General Organization and Function

The kidneys are paired organs located retroperitoneally high on the posterior abdominal wall. Each kidney is surrounded by three layers of connective tissue: The outermost layer is called the Renal Fascia. The renal fascia is a thin layer of fibrous connective tissue which anchors the kidney to the abdominal wall and to other adjacent structures. The middle layer is called the Adipose Capsule. As the name indicates, the adipose capsule is a layer of adipose tissue designed to protect the kidney from mechanical trauma. The innermost layer is called the Renal Capsule. The renal capsule is a thin but tough collagenous capsule composed of dense irregular connective tissue. The renal capsule is continuous with the hilus of the kidney and with the tunica fibrosa of the associated ureter. The functional and structural subunits of the renal parenchyma are the Urineriferous Tubules. The urineriferous tubules are radially arranged around a cavity called the Renal Sinus. This radial pattern causes the kidney to be "bean-shaped". The renal sinus has an

expanded portion of the ureter called the Renal Pelvis. The renal pelvis will branch into the Major and the Minor Calyces. The minor calyces collect urine from the uriniferous tubules and drain into the major calyces. The ureter will exit the kidney at a concave depression on the medial surface called the Hilus. The renal artery and vein will also pass through this hilus. The uriniferous tubules will receive a portion of the circulating plasma that is routinely filtered away from the incoming renal blood supply. The epithelium of these tubules will modify the filtered plasma as it passes through the various segments of the tubules. Most of the water and essential constituents will be resorbed by the tubules and returned to the blood. The remainder, which will contain mostly toxic metabolites, is concentrated and excreted as urine. As a result the histology of the renal parenchyma represents an intimate morphological relationship between the renal vasculature and the uriniferous tubules. Since specific portions of the uriniferous tubules are found in specific regions of the parenchyma, the kidney is divided into a Cortex and a Medulla.

The cortex is the outer portion of the kidney, immediately deep to the renal capsule. There are two zones to the cortex: (a) an outer zone called the Cortical Zone, (b) and an inner zone, immediately adjacent to the medulla, called the Juxtamedullary Zone. The cortex will send extensions into the medulla. These extensions are called Renal Columns/Cortical Columns. The medulla is deep to the cortex and surrounds the renal sinus. It is divided by the renal columns into pyramidal shaped portions called Renal Pyramids/Medullary Pyramids. There are between 8 and 18 renal pyramids. The base of each renal pyramid faces the cortex. The apex of each pyramid is called the Papillae and projects into the funnel-shaped opening of a minor calyx. The kidney is a multilobed organ. A renal lobe is defined as a renal pyramid and the renal columns flanking it. Each lobe is associated with it's own minor calyx. The uriniferous tubules of each lobe open on the papilla and form a perforated structure called the Area Cribosa.

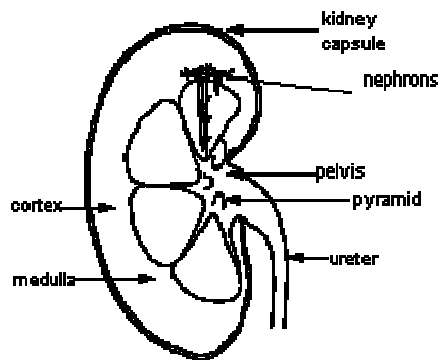


Fig.16.2. The structure of the Kidney

16.2.2. An Overview of the Uriniferous Tubules

The uriniferous tubules are composed of two distinct functional regions. The two regions are: [a] the Renal Tubule which is involved in the production of urine, [b] and the Collecting Tubule which is involved in the hypertonic concentration of the urine. These two regions arise separately from one another in the embryo. In the mature kidney several nephrons will fuse with and empty into a single collecting duct.

a) The Renal Tubule

The renal tubule is a part of the functional unit called the Nephron. The Nephron - is defined as a renal tubule and it's associated vascular components. The renal tubule of the

nephron is a continuous tubule consisting of histologically and functionally distinct regions along its length. composed of a simple epithelium. The renal tubule begins within the cortex as Bowman's/Glomerular Capsule. Bowman's capsule is an indented, blind-ended pouch. Associated with Bowman's capsule will be specialized capillaries, located within the indentation, called Glomerular Capillaries. Together the glomerular capillaries and the glomerular capsule form the Renal Corpuscle of the nephron. This is where blood is filtered by the kidney to begin the formation of urine. The resultant filtrate is termed the Glomerular Filtrate. The glomerular filtrate will flow from Bowman's capsule to other portions of the renal tubule where it will be modified through a process of tubular resorption and tubular excretion.

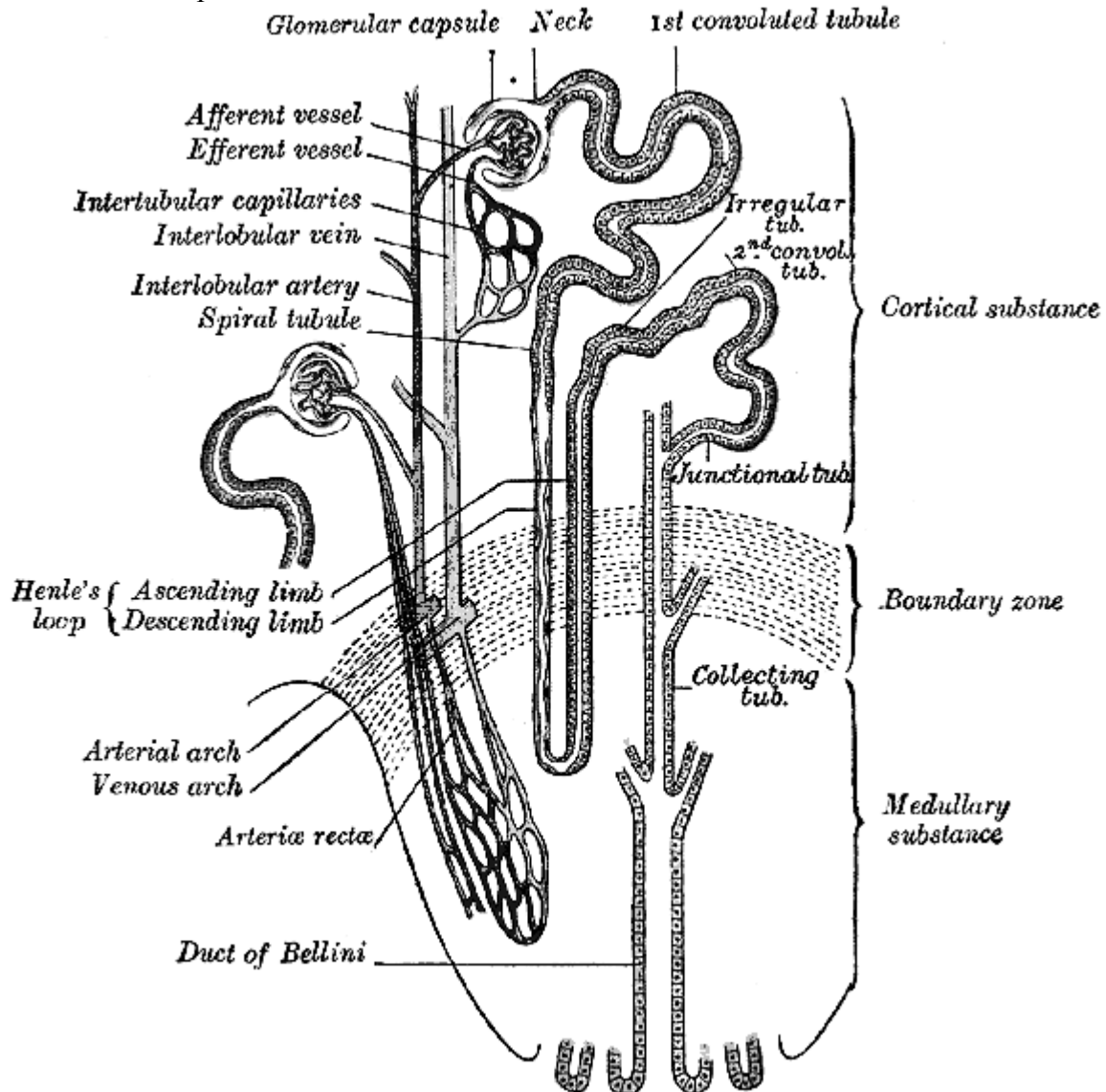


Fig.16.3. The Nephron

[1] **The Proximal Convoluted Tubule** receive the filtrate from the glomerular capsule. The proximal convoluted tubule is also located in the cortex but travels towards the medulla.

[2] **The Proximal Straight Tubule** receive the precocial urine from the proximal

convoluted tubule. The proximal straight tubule is located in the medulla and dives down towards the pelvis..

❸ **The Distal Straight Tubule** receive the precocial urine from the proximal straight tubule. The distal straight tubule is also located in the medulla but travels up towards the cortex.. The proximal straight and distal straight segments of the renal tubule form the Loop of Henle and are also known as the Ascending and Descending Limbs respectively. The Distal Convoluted Tubule receive the filtrate from the distal straight tubule. The distal convoluted tubule is also located in the cortex. This is to allow for some regulatory influences to occur. The distal straight tubule empties into the collecting tubule.

b) The Collecting Tubule

Within the cortex several distal convoluted tubules will empty into a collecting tubule. The distal convoluted tubule is connected to the collecting tubule by short Connecting Tubules. The portion of the collecting tubule located in the cortex and receiving urine from the distal convoluted tubules is often referred to as the Collecting Duct. The collecting tubule will extend through the medulla and open into the minor calyx. The portion of the collecting tubule which travels through the medulla is often referred to as the Papillary Duct. The papillary ducts and loops of Henle are clustered into small parallel groups called Medullary Rays in the medulla.

16.2.3. The Blood Supply of the Kidney

a) Arterial Flow

The Right and Left Renal Arteries branch off of the abdominal aorta, one going to each kidney. After entering the hilus the renal artery splits into the Segmental Arteries. There are typically segmental arteries in each kidney called the dorsal and ventral branches. The segmental arteries branch into the Lobar Arteries. The lobar arteries branch into the Interlobar Arteries which will each penetrate a cortical column. They will extend radially to the corticomedullary junction. At the corticomedullary junction the interlobar arteries bifurcate and give rise to the Arcuate Arteries which will arch around the base of a medullary pyramid. The arcuate arteries give rise to a number of smaller arteries called the Interlobular Arteries which will travel towards the renal corpuscle. At the renal corpuscle the interlobular artery will branch into the Afferent Arteriole. The afferent arteriole will branch into the Glomerular Capillaries of the renal corpuscle. The glomerular capillaries will drain into the Efferent Arteriole.

b) Capillaries

From this point the efferent arterioles of the two types of nephrons differ. There are two types of nephrons. One type has its renal corpuscle located in the cortical zone and does not extend very far into the medulla. It is the Cortical Nephron. The second type has its renal corpuscle located in the juxtamedullary zone and does extend far into the medulla. It is the Juxtamedullary Nephron. The juxtamedullary nephron has a much longer loop of Henle segment and two associated capillary beds which is why it is responsible for the bulk of water resorption. The cortical nephron's loop of Henle has one associated capillary bed. The efferent arteriole coming off of a renal corpuscle from a cortical nephron will branch into the Peritubular Capillary Bed. The peritubular capillary bed will be in close association with the renal tubule from the proximal convoluted to the distal convoluted segments. The efferent arteriole coming off of a renal corpuscle from a juxtamedullary nephron will branch into two capillary beds. One is the Peritubular

Capillary Bed which will be in close association with the renal tubule from the proximal convoluted to the distal convoluted segments. The other is the Vasa Recta which will actually arise from peritubular capillaries. These are thin walled capillaries that are arranged into long, recurrent loops running through the medulla. It acts as a counter-current mechanism in the resorption/secretion of salt and water.

c) Venous Supply

c) Venous Supply is for the most part a mirror image of the arterial supply. (1) The capillary beds are drained by the Interlobular Veins. (2) The interlobular veins are drained by the Arcuate Veins. (3) The arcuate veins are drained by the Interlobar Veins. (4) The interlobar veins are drained by the Lobar Veins. (5) The lobar veins are drained by the renal vein which exits the kidney at the hilus.

Some individuals will have Segmental Veins which will drain the lobar veins and drain into the renal vein. The right and left renal veins will drain into the inferior vena cava.

16.2. 4. The Histology of the Renal Corpuscle

The renal corpuscle, or glomerulus, is the portion of the nephron responsible for the filtration of blood. It is composed of two structures that are in close association: the glomerular capsule and the glomerular capillaries.

a) Bowman's/Glomerular Capsule

The glomerular capsule is the start of the renal tubule. It has two walls, an outer wall and an inner wall. The outer wall of the glomerular capsule is called the Parietal Layer. It is also known as the parietal epithelium or capsular epithelium. The inner wall is called the Visceral Layer and begins where the capsule has been indented to accommodate the glomerular capillaries. It is also called the visceral epithelium or glomerular epithelium. Between the two walls is a space called the Capsular Space/Urinary Space. The glomerular filtrate crosses into the capsular space from across the visceral layer. The urinary space is continuous with the lumen of the rest of the renal tubule. This fact causes the renal corpuscle to be divided into two poles:

1} Vascular Pole - where the glomerular capillaries are located.

2} Urinary Pole - where the capsule joins the proximal convoluted tubule.

b) The Epithelium of the Glomerular Capsule

The epithelium of the parietal layer is a simple squamous epithelium. At the urinary pole it ends to be replaced by the simple cuboidal epithelium of the proximal convoluted tubule. At the vascular pole it is continuous with the epithelium of the visceral layer. The epithelium of the visceral layer is a highly modified simple epithelium. These epithelial cells are called Podocytes. Podocytes have large primary processes which wrap around the glomerular capillaries. Branching off of the primary processes are numerous small secondary processes called Pedicels. Pedicels of adjacent primary processes interdigitate with one another. The spaces between these interdigitating pedicels are called Slit Pores/Filtration Slits. Slit pores are about 25 nm wide and are covered by a thin membrane referred to as the Slit Membrane. The visceral epithelium is designed to have an extremely close association with the glomerular capillaries so as to better filter the blood.

c) The Glomerular Capillaries

Glomerular capillaries are fenestrated capillaries lacking diaphragms over the fenestra. These fenestra serve as another means of filtering the blood. An unusually thick basal lamina intervenes between the podocytes and the endothelium of the glomerular

capillaries. This basal lamina serves as another means of filtering the blood. It is actually the fusion of the components of the basal lamina from both the podocytes and the endothelial cells. The Filtration Membrane (aka; filtration barrier) - allows for the filtration of blood by the nephron and consists of three things: The blood will first encounter the fenestra of the glomerular capillaries. Due to the lack of diaphragms they allow for a rapid flow of plasma across the capillary wall. Due to their size, however, the fenestra prevent the passage of formed elements. The plasma will next encounter the basal lamina. The basal lamina is selectively permeable based on molecular weight and size. They restrict or prevent the passage of substances over 10 nm in diameter. They restrict or prevent the passage of substances over molecular weight of 68,000 amu. Note; albumin has a molecular weight of 65,000 amu. Smaller substances, such as simple sugars, amino acids, metabolites, and even small peptides, can pass freely across the basal lamina. Some new evidence appears to indicate that the basal lamina may also be selectively permeable based on electrostatic charge. The final barrier to filtration is the size of the filtration slits (or slit pores) between the pedicels. The driving force for filtration is pressure, called filtration pressure. Filtration pressure is the net difference in the sum of glomerular hydrostatic pressure (in the blood vessels) and osmotic pressure of the glomerular capsule.

16.2.5. The Histology of the Proximal Convoluted Tubule

As the glomerular filtrate passes through the uriniferous tubules most of it's volume and much of it's dissolved constituents are absorbed by the tubules and returned to the blood. The remainder becomes more concentrated. In mammals most of reabsorption (~80%) occurs in the proximal tubule in general and most of that in the proximal convoluted tubule in particular. The materials resorbed are retrieved by the peritubular capillaries. The remaining materials to be recovered from the precocial urine are resorbed in the distal tubule. The proximal tubule will resorb amino acids, small proteins, glucose, and electrolytes such as sodium, potassium, chloride, and bicarbonate. Sodium is actively transported out of the tubule and into the capillaries. Since this requires energy, the cells of the proximal convoluted tubule will have many mitochondria. The active transport of sodium establishes a diffusion gradient for the passive transport of anions particularly chloride. This, in turn, establishes a diffusion gradient for osmosis.

Nitrogenous wastes such as urea, uric acid, ammonia, and creatine are not resorbed . They become more concentrated in the tubule as resorption occurs. They are actively secreted into the tubule from the blood. Tubular resorption and tubular secretion are designed to modify the glomerular filtrate so as to create a urine which maintains homeostasis in the body. The epithelium of the proximal convoluted tubule is a simple cuboidal type and displays many adaptations to serve it's role in tubular secretion and tubular resorption. Again, the proximal convoluted tubule performs the bulk of tubular resorption and a good deal of tubular secretion. The adaptations are: [a] a complex series of interdigitations between adjacent cells, [b] basal infolding of the plasmallema, [c] numerous basally oriented mitochondria in each cell, [d] and a well developed "brush border" composed of many, long microvilli. Another feature of these cuboidal cells is a central, spherical nucleus.

16.2.6. The Histology of the Loop of Henle

The loop of Henle consists of the proximal straight tubule and the distal straight tubule. It has both Thick and Thin Segments due to it's variable histology. Thin segments make up

most of the distal straight tubule, all of the connector between the distal and proximal straight tubule, and some of the proximal straight segment. The junctions between the thin segment and both thick segments is marked by a sudden change in the diameter of the tubule both in terms of the overall diameter and the diameter of the lumen. This is due to the fact that the thin segment plays a lesser role in tubular secretion and tubular resorption than do the thick segments. The loop of Henle is divided into a Descending Limb, the proximal straight tubule, and an Ascending Limb, the distal straight segment. The renal medulla is divided into an Outer Zone and an Inner Zone. This is due to the fact that the thick segment of the ascending limb extends further into the medulla than does the thick segment of the descending limb. The boundary between the inner and outer zones is marked by the junction of the ascending thin segment and the ascending thick segment. The inner zone contains only ascending thin segments. The outer zone contains: ascending thick segments, descending thick segments, and descending thin segments. The loops of Henle are located within the medulla rays. The loops of Henle of the juxtamedullary nephrons are longer than are those of the cortical nephrons. The juxtamedullary nephrons will also have a longer thin segment.

a) The Thick Segment of the Proximal Straight Tubule/Descending Limb: This portion of the loop of Henle is lined by a simple cuboidal epithelium that is identical to that of the proximal convoluted tubule.

b) The Thin Segment: The thin segment is composed of a simple squamous epithelium. This causes it to be "thinner" and to have a larger luminal diameter.

c) Characteristics: [1] a nucleus that bulges into the lumen of the tubule, [2] the presence of few, short, thinly scattered cilia, [3] a decreased number of mitochondria, [4] lack of basal infolding of the plasmallema, [5] each cell will also have a single flagellum projecting into the lumen.

d) The Thick Segment of the Distal Straight Tubule/Ascending Limb: This portion of the loop of Henle is lined by a simple cuboidal epithelium that is identical to that of the distal convoluted tubule.

16.2.7. The Histology of the Distal Convoluted Tubule

The distal convoluted tubule, like the proximal convoluted tubule, is located in the renal cortex. It will attach to the collecting tubule via the connecting duct. The distal convoluted tubule, like the proximal convoluted tubule, is lined by a simple cuboidal epithelium. However, since it does less of tubular resorption and about the same amount of tubular secretion as does the proximal convoluted tubule, its cells show a lesser degree of modification. Although they are better designed for the passage of materials between the tubule and the blood than are the squamous cells of the thin segment. The characteristics of these cells compared to those of the proximal convoluted tubule include: [a] fewer, more broadly distributed mitochondria, [b] a more apically oriented nucleus, [c] less basal infolding of the cell membrane, [d] and fewer, shorter microvilli. This decrease in the length of the microvilli results in the lumen of the duct being wider than that of the proximal convoluted tubule.

16.2.8. The Juxtaglomerular Apparatus

The juxtaglomerular apparatus is made up of modifications of the distal tubule and the afferent arteriole. They are designed to regulate the rate of filtration and the volume of urine produced. The juxtaglomerular apparatus consists of the macula densa of the distal tubule and the juxtaglomerular cells of the afferent arteriole.

a) The Macula Densa

The macula densa is a short, specialized region of the distal tubule located between the distal straight and distal convoluted tubules, immediately adjacent to the afferent arteriole. The macula densa forms a contiguous relationship with the vascular pole of its renal corpuscle. The cells of the macula densa are specialized epithelial cells termed Macula Densa Cells. [a] They are smaller than are the other epithelial cells of the tubule and are more densely packed together. [b] They are flattened in appearance. [c] They monitor ion levels, particularly chloride and sodium, in the precocial urine of the distal tubule. [d] They are in close association with the outer wall of the afferent arteriole and, to a lesser extent, with the outer wall of the efferent arteriole. The afferent arteriole lacks a tunica adventitia and so the cells are actually in contact with the tunica media. The macula densa cells lack a basal lamina. So there is nothing between them and the tunica media.

b) The Juxtaglomerular Cells

The juxtaglomerular cells are modified smooth muscle cells of the afferent arteriole. They replace the normal complement of smooth myofibers found in an arteriole. They are in direct contact with the macula densa cells of the distal tubule. They have large cytoplasmic granules containing renin. When released into the blood stream renin will interact with Angiotensinogen to form Angiotensin 1 which will then react with a blood enzyme to form Angiotensin 2. Angiotensin 2 is a powerful vasoconstrictor which will act on the efferent arteriole. Angiotensin 2 will also stimulate the release of aldosterone from the zona glomerulosa of the adrenal gland. Aldosterone will promote the increased secretion of sodium by the nephron.

Renin will be released into the glomerular capillaries from the juxtaglomerular cells. The release of renin is triggered by the macula densa cells due to low ion levels in the precocial urine of the distal tubule. The release of renin can also be stimulated by a decrease in renal blood pressure. The juxtaglomerular cells are also innervated by unmyelinated adrenergic fibers to allow for neural control over the release of renin. Associated with the juxtaglomerular apparatus are a cluster of specialized cells called Lacis Cells. Lacis cells are also called Goormaghtigh cells or polkissen cells. Lacis cells are similar in appearance to the juxtaglomerular cells except that they have an agranular cytoplasm. The cluster of Lacis cells is located between the glomerular capsule and the macula densa. They are found between the walls of the efferent and afferent arterioles and form what is known as the Extraglomerular Mesangium. They are continuous with the Mesangial cells of the Intraglomerular Mesangium. The function of the Lacis cells is unclear but they are believed to play a phagocytic role removing debris occluding the filtration membrane.

16.2.9. The Histology of the Collecting Tubules

The collecting tubules convey urine from the renal tubule, through the medulla, to the minor calyx where they open up at the area cribosa. The collecting tubule is divided into the Collecting Duct and the Papillary Duct. The collecting ducts are located in the cortex and receive urine from several renal tubules by means of the Connecting Ducts. Connecting ducts are short, tubular segments lined by a simple cuboidal epithelium. The papillary ducts are straight, unbranching tubules extending from the corticomedullary zone to the area cribosa. The collecting tubules are the principle site for the action of ADH, antidiuretic hormone. ADH will also affect the distal convoluted tubule but to a

lesser extent. ADH increase the permeability of the collecting tubule so that water may be resorbed from the precocial urine. This will further concentrate the urine. The collecting ducts are lined by a simple cuboidal epithelium with distinct boundaries. These cells have basally oriented nuclei. There are two cell types recognized:

a) Principle Cells - which are responsible for ADH permeability. They are the more numerous type.

b) Intercalated Cells - which may be involved in potassium resorption. They are less numerous than are the principle cells. Their numbers diminish closer to the medulla. They are at their greatest number near the connecting ducts and decrease steadily. The papillary ducts are mostly lined by a simple cuboidal epithelium. However, this cuboidal epithelium is taller than is that of the collecting duct and increase in height closer to the area cribosa. Near the terminus of the papillary duct the epithelium switches to a simple columnar. Papillary ducts have only one cell type, the principle cells.

16.2.10. The Histology of the Minor and Major Calyces

The histology of the minor and major calyces is similar to that of the ureters. The epithelium is a transitional epithelium resting on a sparse lamina propria.

16.3. The Ureters

Urine will travel from the renal pelvis into the ureters where it is carried by peristalsis into the bladder. Each of the two ureters is a continuation of the renal pelvis. They are about 30 cm in length. As they approach the bladder the ureters increase in thickness. The ureters will enter the bladder at the superior lateral angle of it's base. The ureters lack anatomical valves but have functional valves. When the bladder is full it will press back upon the ureters preventing more urine from entering into the bladder. Pressure in the bladder prevents urine from flowing backwards into the ureters.

2. The ureter has three tunics.

a) Tunica Mucosa - the innermost coat

It is a mucus membrane composed of transitional epithelium sitting on a lamina propria. The epithelium secretes mucus to protect itself from the acidic nature of urine and also from some of the solutes present in urine. The transitional epithelial cells have occluding junctions so as to separate the urine from the capillaries in the lamina propria. The lamina propria has an extensive capillary network and also contains elastic fibers.

b) Tunica Muscularis - the middle and thickest tunic

Along most of its length the tunica muscularis is composed of two sheets of smooth muscle. It has an inner sheet of longitudinally arranged muscle and an outer sheet of circularly arranged muscle. In the third of the ureter proximal to the bladder the tunica muscularis has three sheets of smooth muscle. They are arranged: longitudinal, circular, and longitudinal. This adds to the thickness of the ureter's wall. It also adds to the effectiveness of the functional valves. Contractions of this muscularis move the urine through the ureter by means of peristalsis.

c) Tunica Fibrosa - the outermost tunic

This is a layer of fibrous c.t continuous with the renal capsule.

16.4. The Urinary Bladder

The urinary bladder is a hollow, muscular organ which stores urine prior to micturition (urination). It is located in the pelvic cavity posterior to the pubic symphysis. It is freely movable, to allow it to handle a large volume of urine, and held in place only by folds of

the peritoneum. Its shape will depend on its level of distension. At the base of the bladder, internally, there is a triangular region called the Trigone. This is an area of the bladder's tunica mucosa which will be free of its customary folds. These folds are called Rugae and serve to increase its distensibility. The apices of the triangle are the openings of the two ureters and the urethra. The urinary bladder has four tunics.

a) Tunica Mucosa - the innermost tunic.

It is very similar to that of the ureters being transitional epithelium sitting on top of a lamina propria. The transitional epithelium, coupled with the rugae, help it to stretch. Elastic fibers are more numerous in the lamina propria of the bladder. Along with adding to its distensibility they also allow for the formation of rugae. The mucosa will have a greater number of unicellular mucus secreting glands.

b) Tunica Submucosa - the second tunic.

This is a layer of dense c.t. that serves to bind the tunica mucosa to the tunica muscularis. It contains numerous blood vessels traveling to the lamina propria.

c) Tunica Muscularis - the third tunic

It is composed of three sheets of smooth muscle (arranged: longitudinal, circular, and longitudinal) collectively called the Detrusor Band. At the urethral opening fibers from the circular layer form the Internal Urinary Sphincter. External to the internal sphincter is the External Urinary Sphincter which is composed of skeletal muscle and under voluntary control. An extensive nerve plexus, including ganglia containing numerous cell bodies, travels into the muscularis from the serosa to control the detrusor band.

d) Tunica Serosa - the outermost tunic.

It is a covering of visceral peritoneum continuous with that of the neighboring organs.

16.5. The Urethra

The urethra is a small tube leading from the floor of the bladder to the external environment. In females the urethra lays posterior to the pubic symphysis and is embedded in the anterior vaginal wall. Its opening, the Urethral Orifice, is located between the clitoris and the vagina and will open into the urogenital vestibule. The urethra averages 3.8 cm/ 1.5 inches in women. In males the urethra also plays both an excretory and a reproductive role. It passes through an accessory sex organ, the prostate, through the urogenital diaphragm, and then enters into the penis. The urethral orifice is located at the distal end of the glans penis. The urethra will be longer in males averaging about 20 cm or 8". The tunics of the urethra also vary between the genders. (a) Both have a Tunica Mucosa continuous with that of the bladder. (b) Both have a Tunica Submucosa of dense c.t. rich in blood vessels. (c) Only females, however, have a third tunic, a Tunica Muscularis, composed of a circular smooth muscle sheet. Overall the tunics of the urethra are consistent with those of the other urinary excretory passageways. The tunica mucosa is different, however. Although in females it is a transitional epithelium resting on a lamina propria, as is the case in the ureters and the bladder, in males the epithelium is variable. This is due to the reproductive function of the male urethra and will be covered in detail in that unit.