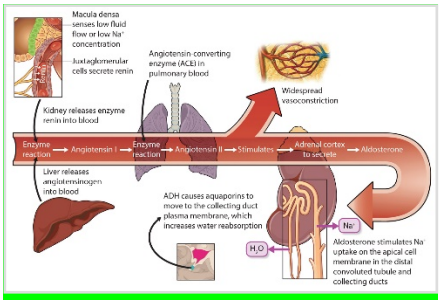
# Renal RRM Ch 24 MH

## Sections 24.1,2,3,5,6, Fig 24.25, 24.8

Please read, visualize and recall: Kidney (Renal)… It is a most magical thing, the kidney, and very complex, but it operates on very basic principles. This unit will apply much of what you already know in terms of blood flow and volume (recall RAAS and ADH hormones), and fluid transport via concentration gradients. Recall the basics in terms of gravity, flow, and increased pressure of a fluid due to decreased space.

Know that the kidney regulates fluid volume, and produces urine. The renal system is our pair of kidneys (remember the adRENAL gland?) Visualize a kidney punch (inferior, lateral and posterior). That's where they are, stuck to our back. Recall RAAS, from Ch 17.

**Please see 24.1**: 1. List four things you did NOT know about the function of the Renal System:




This is actually a system that I am rather well educated on due to it's relation to family medical conditions… So, if it's okay, I'm going to list what I think is so fascinating about this system.

1. How many nephrons there are, in the range of 1,000,000
2. How simple the structure of the nephron is. But the fact that the interconnectivity of the regions thereof make it the hardest system to effectively master (and why I consider nephrology as a specialty to be informationally more dense than neurosurgery (though they have nephrologists beat for procedural difficulty))
3. How easily influenced the hormones involved are from activities of daily living
   Case in point, caffeine's limiting influence on ADH (written with a Venti Cold Brew next to the laptop)
4. How interconnected it is with the other major systems of the body.
5. How effectively a blow to it will take down a guy twice one's size
   (this is a joke BTW that may or may not be drawing from experience)

2. Which is lower, the right or left kidney? *The Right Kidney.* They are also *retroperitoneal*. Say what? This simply means that they are located in the back of the peritoneum.

What is a **hilum**? Where the vessels, nerves and ureter pass into the kidney.

3. Check out the image **Fig 24.3** and reading below **24.2b**. What is the role of gravity here?

Gravity facilitates the movement within the nephron.

**See Section 24.3** Lets get some terms figured out first, then put them together.

4. Please define:

Renal cortex: The outer layer of the kidney.

Renal medulla: The body of the kidney.

Nephron: The microscopic filtration unit of the kidney.

Glomerulus (I think: "glob"): A thick tangle of capillary loops.

Bowman's capsule. Blood becomes "filtrate" or filtered urine.

Afferent arteriole: The arteriole that enters the kidney.

Efferent arteriole: The arteriole that exits the kidney.

Distal convoluted tubule or DCT (I think: "far away-from the glob-crazy tube"): Originates in the renal cortex and extends to a collecting tubule, and is composed of simple cuboidal epithelium. Has fewer epithelium compared to it's proximal counterpart, and appears smooth/clear when viewed under a microscope.

Proximal convoluted tubule or PCT: The first region of the renal tubule. Categorized by simple cuboidal epithelium with tall, apical microvilli that increase surface area/reabsorption.

*Loop of Henle or LOH or nephron loop:* a loop in the nephron that dips down into the renal medulla. Thick and thin portions alternate and regulate Na ion concentration. I don't know how exactly to respond to this since, it comes off as a "you already answered this" situation.

5. Now, connect them in order so that blood is coming into glomerulus, moves into the thick, then thin descending, then thick ascending LOH (Loop of Henle-this thing is MAGIC!) and back out again.

I'll start:
1. Within a nephron blood entered the renal medulla via
2. renal cortex, blood comes into the glomerulus via the
3. efferent arteriole, then into the Proximal Convoluted Tubule
4. moves into the loop of henle where, due to (hydrostatic) pressure, the fluid leaks out and large particles-such as proteins- continue to move through. It the flows into the Distal Convoluted Tubule where it is further filtered before draining into the collecting duct.

**Recall the difference between the adrenal cortex (outer) and medulla? (inner)**

**Section 24.3, cont**. 6. Please see Fig 24.5. Looking at the picture (and perhaps reading), distinguish where the two types of nephrons lie. (Location, location, location is very important for concentration gradient).

Therefor *corticomedullary* means between the cortex and the medulla.

7. Please see Fig 24.7. What does the juxta (means "near") apparatus do for blood volume (and what does it release)?

The juxtaglomerular apparatus is important for regulating filtrate formation and systemic blood pressure. This is accomplished by the coordination of granular cells, and macula dense cells. The granular cells detect stretch by the sympathetic nervous system, as well as storing renin. While the macula densa cells detect changes in NaCl concentration of tubular fluid. This information is used, in turn to adjust the body's overall fluid levels/concentration.

8. See Fig. 24.4b. Describe the path of fluids starting with the microscopic view of flow, then the macroscopic view of flow, starting with the nephron and exiting out the body.

*From a microscopic view*: Fluid enters the nephron at the cortical nephron where the majority filtration takes place in the proximal convoluted tubule. Fluid filtration then takes place within the descending limb, before the remaining filtration of this stage occurs in the Distal Convoluted Tubule. The fluid then moves into the collecting duct, where the fluid (urine) is further drained of water. It is then drained into the bladder.

From a macroscopic view: Renal Artery ->Segmental Artery -> Interlobar Artery -> Arcuate Artery -> Interlobar Artery -> Glomerulus -> Efferent Arteriole -> Interlobar Vein -> Arcuate Vein -> Interlobar Vein -> Renal Vein

9. How is urine actually formed and drawn from the blood? What does the renal system do and how does it go from fluid in the blood to urine? See Fig 24.10 for assistance, and please summarize the three major steps/pathways only.

Urine is formed via filtration, reabsorption, and secretion. The three major steps are

Glomerular Filtration:Where water and dissolved solutes are passively separated via pressure differences.

Tubular Reabsorption: Where components are filtered by the lumen of the renal/collecting tubules, and collecting ducts, where the fluid is then reabsorbed via the peritubular capillaries and vasa recta. Most vital solutes/water are reabsorbed, while excess solutes, some water, and waste products remain.

Tubular Secretion: Is where solutes are moved via active transport, out of the blood within the peritubular capillaries/vesa recta into the tubular fluid. Where they are then selectively removed from the body.

**See Section 24.5d. Please answer each of these *four questions* by including the Q in your answer:**

For example,
a) Glomerular Hydrostatic Pressure or GHP is the driving force for moving water and dissolved solutes out of the blood and is higher than that in other capillaries because GHP

b) Two opposing P (they decrease the P going out) are

Blood Colloid Osmotic Pressure and Capsular Hydrostatic Pressure

c) What is the formula for Glomerular Hydrostatic P?

Net Hydrostatic Pressure = Glomerular Blood Hydrostatic Pressure - (Capsular Hydrostatic Pressure + Blood Colloid Osmotic Pressure)
Or

NHP = GNHP - (CHP + BCOP)

d) GFR is Glomerular filtration rate is changed by (3 things) See p. 964 also.

Renal auto regulation

Direct stimulation via the sympathetic nervous system

Atrial natriuretic peptide (ANP)

See Fig. 24.13 What does changing the lumen diameter of the afferent arteriole do to the glomerulus (glob) after it? (Recall what you know about vessel constriction and dilation)

It changes the volume of blood that is entering the glomerulus, directly effecting the amount of blood that can thus be filtered.

**Section 24.6.** One of the things you might have been unaware of is that the kidneys will REabsorb glucose among other things. First, when we talk about REabsorption, this means that something was absorbed, sent out then Reabsorbed. (FYI, ~ means approximately)

1. Please explain (summarize) glucose reabsorption

Under normal circumstances, 100% of glucose is reabsorbed into the blood. This happens by glucose moving up its concentration gradient via secondary active transport.

2. Please explain why increased urine production *and* dehydration are symptoms of diabetes mellitus?

   Because of the hydrophilic nature of glucose, it draws water that would otherwise be reabsorbed by the body. Hence the polyuria and dehydration that represents textbook diabetes.

3. What hormones influence sodium reabsorption and what do they do? (Increase/ Decrease?) Please see T 24.2
   *Aldosterone*: A steroid hormone that binds with intracellular receptors that forms a hormone receptor complex that stimulates the reabsorption of sodium.
   *Atrial Natriuretic Peptide (ANP)*: Inhibits the release of aldosterone, thus acting to decrease sodium reabsorption

4. How does ADH (recall "Anti D holds your pee") enhance water reabsorption?

   ADH binds to receptors of the Principle cells of the collecting tubules/ducts to increases the migration of vesicles containing aquaporins to the luminal membrane.

**See Fig 24.25.** With the above as your background information, explain how the Loop of Henle maintains Na and Water levels in the tubule as it ascends and descends through the cortex and medulla of the kidney.

The Loop of Henle (Nephron Loop) effects fluid concentration via a concentration gradient for reabsorption that is established by the presence of ADH.

**Please see Clinical View 24.5.** Your patient Luca has had an autoimmune disease since COVID started. He now has renal failure. What is it and how will you treat it? Please explain:

Renal failure is when the kidneys are no longer capable of functioning at a capacity that is compatible with human life. Depending on the severity, it can be managed as a Chronic Condition, or is outright terminal without a transplant. In an ideal situation, a donation will be done as soon as possible, ideally from a living donor, who more ideally is an identical twin (though this is uniquely the one medical procedure that is done at the detriment of the patient i.e. donor).

It's most often managed through dialysis, in which the patient is hooked up to a machine that is designed to filter the blood in a way that is very similar to renal filtration. The effectiveness of this varies on case by case basis. However, it is possible to live a mostly normal life while doing dialysis.

**24.8:** 1. Please list the 7 factors that increase urine volume:

Decrease in ADH

Decrease in aldosterone

Increase in ANP

Increase in Fluid Intake

Increase in Blood Pressure

Diabetes mellitus

Diuretics

2. What is the route from kidneys out….for *micturition*? Say what?

Urine leaves the collecting ducts to enter the ureters where it travels down into the bladder. Where it is stored for elimination (ie micturition)