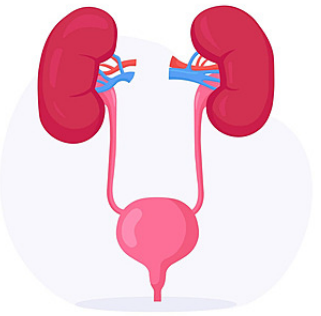
The Urinary System

Consists of :
* 2 kidney (Filtrate blood)
* 2 Ureters
* Urinary bladder
* Urethra



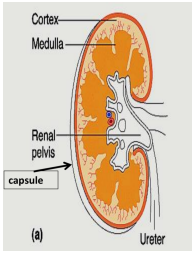
Function :
*Removing waste & water from body (as drug & uric acid)
*reabsorption of vital vital nutrient
*Maintain acid - bais balance
*Help in control blood pressure (via RAAS system)
*Help in produce red blood cells (EPO hormone)
* Produce calcitriol (Vit-D) regulate Ca →Healthy bones

Kidney

strucrure of the kidney :

1. Stroma : capsule

2 . Parenchyma :



*The kidneys had endocrine function (production of renin & EPO)
And exocrine function (production of urine)

*Nephron : is the microscopic structural and functional unite of the kidny that perform filtration of blood

Each kidney contains 1-1.4 million nephrons

Each nephron consists of :
1. Renal (malpighian) corpuscle
2. Proximal convoluted tubule (PCT)
3. Loop of henle
4 . Distal convoluted tubule (DCT)

* Each 4-6 nephrones will open in one collecting duct

Cortex :

- Cortical labyrinth : areas that contain renal corpuscles and Convoluted tubules

- Medullary rays : are regions where the straight segment Of loop of Henle's + collecting duct travel in radial fashion from medulla to cortex

- Bands of cortical labyrinths searate the areas of Medullary rays

- Each medullary ray with 1/2 of the adjacent cortical labyrinth on either side is a Lobule

- renal lobule within cortex
- The tissue between 2 interlobular arteries is defined as lobule
- Interlobular arteries bisect labyrinth
- a lobule consists of 1/2 of labyrinth on one side of medullary ray & 1/2 of labyrinth On the other side
- Nephrons of that lobule drain in a single collecring duct

Medulla :

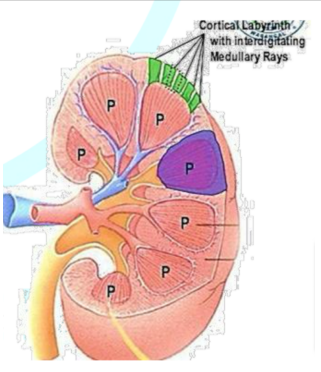
- consists of 8-15 conical structures called Renal pyramids
- The renal pyramids separated by
- (Bertin colmns) cntain BV & Renal tubules .
- Each medullary pyramid + the cortical tissue at its base & along its side form a Renal lobe
- Apex of each pyramid called Renal papillae
- The renal papillae projects into Minor calyx
- 3-4 minor join to form Major calyx , then empty into renal pelvis

Kidney (organization)

* Renal Lobe : A single pyramid with associated overlying cortex

* Renal Lobule : defined within cortex and involve a single medullary ray (central axis of lobule) with adjacent cortical labyrinth

Definedas a functional unite that consists of a collecting duct and all the nephrons that it drains .



Uriniferous tubule

1- collecting duct : contracrion & carries urine to minor calyx
2- nephron : the structural & functional unite of kidney that filter blood wich produce urine

* Classification of nephrons :
- Cortical nephrons : 85% , short loop of Henle , extend close to cortico-medullary junction
- Juxta-medullary nephron : has long loop of Henle , extend deep in the medulla

They are respnsible for setting up medullary osmotic gradient ⟶ Production of concentrated hypertonic urine

Renal (malpighian) corpuscle

-Renal corpuscle is where blood filtration occurs
- it has 2 part : urinary & vascular parts

Glomerulus

Tuft of capillaries , inside the capsule , supplied by afferent arteriole & drained by efferent arteriole .

- The prefiltered blood enter the glomerulus through afferent a & filtered blood exit through efferent a .

- The afferent arteriole has a thicker media and larger diameter than the efferent one to create a high glomerular pressure ⟶ large quantities of filterate .

- The wall of the glomerular capillaries is lined with [fenstrated endothelial cell]

restrict the passege of blood cell & proteins with [continuous baesment membrane formed of type [IV] (-ve charged) which repel potions (-ve charged) from escaping through

If Abs attack BM cause damage

[Glomerulonephritis]

Bowman's capsule

Double walled chamber has :
A) inner/ visceral layer (podocytes)
B) outer/ parietal layer (simple squamous epithelium)

- Bowman's capsule visceral layer is lined with special cell called [podocytes]

- Podocytes :
* they are flattened cell with several 1ry process
* each 1ry process send numerous 2ry process (pedicles)
* encircle the underlying blood capillary
* 2ry process interdigitate with each other
* forming minute spaces in-between called (filtration slits) closed by semipermeable diaphragm (10-40nm)
* they comprise the main filtration barrier in the glomerulus they also express vit-D receptors
* the cytoplasm of Podocytes contains free ribosomes , rER , mitochondria , Golgi , actin microfilaments (contractility)

Function of podocyte :
1- formation of blood renal barrier .
2- renewal of glomerular basment membrane [GBM].

Blood Renal Barrier

- barrier that separate blood inside glomerular capillaries from glomerular

- Formed of 3 layers :
1) Glomerular endothelium [fenstrated]
2) Basment membrane shared between Podocytes and endothelial cells [continuous & -ve charged]
3) Filtration slit diaphragms

(فَلَنِعمَ المُجيبُونَ) هُو لَا يُعطيكَ مَا أردتَ
فَحسب، هُو يدبّر لكَ المُرهِقَ من كلّ
الجِهات، إنَّه الله، الوِجهة التي لن تخذلك ❤️

Mesangial Cell

- Specialized cells found around capillaries of the kidney .
- They are 2 types :

Intra-glomerular

Specialized pericytes located between the endothelial cells and the basement membrane of glomerular capillaries form [mesangium]

Function :

1) Filtration : regulate blood flow of glomerular capillaries by their contractile activity control (GFR)

2) Structural support to glomerulus

3) Phagocytosis & renwel of BM

Extra-glomerular

[Lacis cell] : Specialized smooth ms cells found outside the glomerulus , at the vascular end .

Function :

1) Signal transmission : play role in renin-angiotensin-aldosterone system.

2) Part of [Juxta-glomerular apparatus] together with macula densa & granular cell .

* May role in secretion of erythropoietin .

* These cells are Oxygen sensory , Main source of this H is pertubular interstitial

Juxtaglomerular Apparatus

-Located at the vascular end of renal corpuscle .

- function : regulation of glomerular filtrare rate & blood pressure through the Renin p-Angiotensin-Aldosterone system .

- consiste of 3 components :

Macula Densa
(Nacl)

A) the part of [DCT] the fits between the afferent & efferent A
* cells become tall columnar

B) The nuclei of cells become deeply stained & closely packed appear as dark spots .

C) 1ry cilia , single non motile Project extend from their surface to detect any osmotic change lumen .

Function :
Act as [osmoreceptor] that monitor the level of Na ions of the filtrate in the lumen of DCT

Juxtaglomerular cells
(Granular cells)

A) modified SM cells present in the [tunica media] of the afferent A

B) nuclei of cell become rounded instead of being elongated

C) cytoplasm contain secretory granules contain (Renin H)

Function :
Secrete Renin H

Extraglomerular mesangial
(Lacis cell)

A) small pale stained cells occupy the space between the afferent A & efferent A and macula densa .

Function :
A) supportive
B) transmits signals from
Macula densa
↓
Glomerulua
↓
Vasoconstriction BV

Renine-Angiotensin-Aldosterone

- drop in blood pressure or blood
  * ↓volume of lomerular filtrate
  * ↓ Na&cl concentration in DCT
  * Macula densa monitor these changes
  * ++ JG calls ⟶ Renin
  * Changes angiotensinogen in blood (formed by liver)⟶ Angiotensin⟶ Lung(has ACE)⟶ Angiotensin 2. ⟶ is : 1- potent vasoconstrictor. 2- +release of Aldosterone from AC & ADH from posterior pitutary

- Aldosterone promotes reabsorption of Nacl by [DCT]
- ADH promotes water reabsorption from [collecting tubules] → Will cause ↑BP

Proximal convoluted tubule	Distal convoluted tubule
– Longer+ narrow lumen. – Lined e 3-5 cells. – Ill-defined cell borders. – Apical brush border. – Reabsorption of water (Na^+ pump), sugar , amino acids. – Secretion of some metabolites (penicillin, dyes, ammonia). – Cells express Vit. D receptors	– Shorter + wide lumen. – Lined e 5-8 cells. – Clear cell borders. – **No brush border**. – Reabsorption of water under effect of Aldosterone. – Cells express Vit. D receptors.

Loop of Henle

- variable in length
- Thin segment : lined by simple squamous
- Thick segment : lined by cubical
- it descend from cortex to medulla

Function :
-Create concentration gradient in the medulla of kidney produc hypertonic urine
[descending limb] has ↑permeability to water ,↓permeability to ions
[ascending limb] is permeable to ions , impermeable to water .

Collecting duct

- The excretory portion of renal tubules , under ADH
-lined with simple cuboidal epithelium , each 6-8 duct drain into tips of medullary pyramid
- 2 types of cells :

Principle cells	Intercalate cells
– Numerous. – Very sensitive to ADH → Responsible for the ability of collecting tubules to concentrate urine. – Reabsorb water. – Reabsorb Na & secrete K.	– Few, have apical microfolds. – 2 types alpha & Beta. – Regulate acid- base balance.e – Alpha → H^+ ion → acid urine. – Beta → HCO_3^- → alkaline urine.

	Urters	Urinary bladder
Mucosa	Trasitional epi CT lamina propria	Transitional epi lamina propria
Musculosa	- upper 2/3 : inner longitudinal & outer circular - lower 1/3 : additional outer longtiudinal	IL , MC& OL (detrusor ms) At the neck of bladder the middle circular form→[internal urethtal sphincter.
	Adventitia Loose areolar CT	Serosa Loose areolar CT

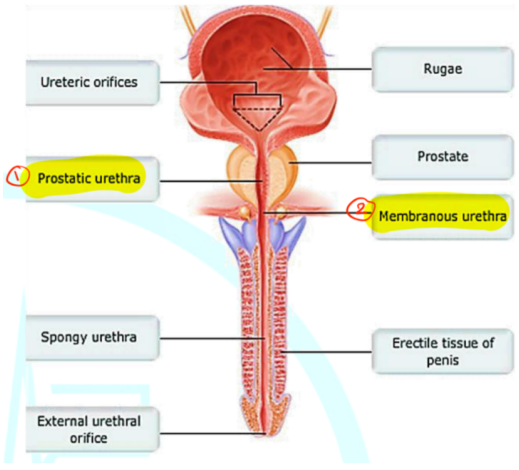
Urethra

Male urethra

Prostatic urethra : Transitional epi

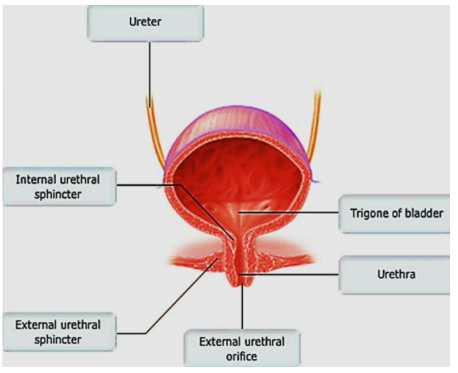
Membranous urethra : Stratified columnar epi

Penile urethra : Stratified columner epi → stratified squamous in distal part (Fossa navicularis)



Female urethra

- short straight tube
- Lined with [trasitional epi] then stratified squamous at its distal part



مالي أراكَ حَزيناً؟!
أحُرمتَ من الجنَّة أم بُشِّرت بالنَّار!
هوِّن عليكَ فكلّ ما دون الجنَّةِ دُون.. هذه الدنيا لا تسوى عند الله جناح بعوضه..!

أَتحزن لأجلِ دُنيا فَانية..؟!
أَنسيتَ الجِنان ذَات القُطوفِ الدَّانية؟!
أتضيقُ والله ربُّك، أتبكي والله حسبُك!

إنَّ اللهَّ معكَ "💕

La Medica Academy
Study Smarter Not Harder

Done by : Balqees Dmour