Kidney has major homeostatic function
↳ to keep the extracellular fluid constant for optimal function of cells

Regulation of:

1. water and electrolyte balance
2. Acid-base balance
   ↳ الجسم لا ينتج أحماض
   lungs تتخلص من بعضها عن طريق
   or fixed acids excreted through the kidney
   - Buffer
   - NH_3 secretion (Amonia)
3. ABP → short term regulation → Renin Angiotensin system.
   long term → regulation of plasma volume

↑ BP → ↑ urination

Excretion of → endogenous → Metabolic waste products (Urea, uric acid, creatine, ...)
exogenous → drugs الإضافات الغذائية

Endocrinal and paracrinal functions →

↓ into the blood

↓ Erythropiotin 85% (Renal failure → Anemia)

Renin

Active form of vitD

to be activated it should be hydroxylated in both the liver and the kidney.

(Renal failure → Bone problems).

↳ into tissue fluid

↳ PGE2, PGI2 → vasodilation

Bradykinin

→ last function:

glucunogenesis

Convert amino acids to glucose.

يتم في الكبد liver بشكل أساسي بنسبة 10% في الكلية kidney.

kidney → 150g → حجمها بحجم قبضة اليد

>12cm x >8cm

Cortex and Medulla

↓ granular and darker

↓ striated and paler

divided into pyramids

↳ end with papilla

ureter ← pelvis ← Major calyx ← minor calyx ←

Types of nephrons → kidney contains 1-3 milion nephrons

Renal corpuscle + Tubules

↓

glomerulus and bowman's capsule (spherical tuft of capillaries between afferent and efferent arterioles).

PCT
loop of Henle
DCT
collecting duct

In contact with afferent arterioles
Because of Juxta-glumerular apperatus

PCT vs. DCT

PCT	DCT
15mm	5mm
Brush border to ↑ the surface area	few microvilli
Many mitochondria	few mitochondria

loop of Henle

Descending limb and ascending

ascending

Thin segment → flat epithelium

Thick segment → cuboidal

Reabsorption of Na

Diluting portion of the nephron

passive in action

Collecting duct → 2 types of cells →

principle cells VS. intercalated cells

P-cells

predominal cells

less microvilli
less mitochondrea
less vesciles

I-cells

less number

More Mitochondria, Microvilli, vesciles.

Acid secretion

HCO_3^- reabsorption

Na-Ka exchange

$3Na^+ \longleftrightarrow 2K^+$ (Aldosterone).

H_2O reabsorbtion (ADH)

Collecting tubules ↓ final adjusment of urine

Depending on the location of the glomerulles:

Cortical nephrons (outer part of the cortex) → that's why the cortex appears granular and dark

Juxtamedullary nephron (near the medulla) → collecting tubules water / pale

- very long loop of Henle
- very short loop of Henle

	Cortical	Juxtamedullary
%	85%	15%
Glomerulus	outer part of the cortex	lower part of the cortex
loop of Henle	Short loop of Henle dips to junction between cortex and inner medulla.	dips to pyramids (Apex).
Blood supply	peritubular capillary	peritubular capillary + vasa recta
Specific function		loop of Henle.. Concentration of urine

Juxtaglomerular apparatus → Area of contact between afferent and efferent arterioles and first part of distal convuluted tubule

3 types of cells →

① Juxtaglomerular cells in media of afferent arterioles some of smooth muscle cells of afferent A. get modified to be epithelial-like cells: secrete Renin (granular) → BP (Baroreceptors)

↓

secreted when → ① renal diffusing pressure ↓

السائل إلى توصيل الكلية من ضغط في

② NaCl concentration decreased in Macula densa (filtration ↓ ← قليل على طول DCT)

↳ ↑ BP. (because of ↓ glomerular filtration rate).

③ β- adrenergic stimulus (↑ Renin release).

② Extraglomerular mesengial cells → Agranular cells

↓ ↓

outside the glomerulus in the middle

at the junction between afferent and efferent arterioles

function: non-known / store of renin

③ Macula densa → DCT

in contact with Afferent and efferent Arterioles

when Nacl ↓ (filtration ↓) macula densa will sense that and will try to ↑ pressure (chemoreceptors) ↑ filtration

↳ Tubuloglomerular feedback

↓

tubule that is in contact with the glomerulus will control the function of the glomerulus

when Nacl ↓ → macula densa will release NO and PGs to dilate the Afferent and will stimulate Juxtamedullary cells to ↑ renin which will constrict the efferent. (Angiotensin II will constrict the efferent).

if Nacl ↑ (filtration ↑) → vasoconstriction of the Afferent

Functions of Juxtaglomerular apparatus →

will control the filtration of the glomerulus (GFR and renal blood flow) → Autoregulation of the individual nephron.

Clinical significance → Excess secretion of renin from juxtaglomerular cells → secondary (renal) hypertension — 90% of hypertension cases are essential, 10% are secondary [with known cause] —

But why could renin secretion be excessive?!

tumor in juxtaglomerular cells or stenosis in the renal artery with subsequent ischemia in the Kidney ⇒ secondary hypertension and secondary hyperaldosteronism ($Na^+ \uparrow$ / $K^+ \downarrow$ / $H^+ \downarrow$)

Renal blood flow → kidneys take 20-25% of CO (cardiac output) ≈ 1.2 - 1.3 l/min

Renal artery → interlobar arteries ↓

interlobular arteries → Afferent arteriole → efferent arteriole

↓

gives peritubular capillary (in juxtamedullary nephrons it will also give vasa recta)

1/5 of the plasma that reached the kidney will be filtered. (GFR).

1.2 L blood/min (625 mL plasma/min)

500 mL plasma ← 125 mL plasma/min will be filtered. (GFR)

بطيء جداً

↳ efferent arterioles → peritubular capillaries and vasa recta (in juxtamedullary nephrons)

⇒ 1/5 inside the tubules and 4/5 in the peritubular capillaries

1/5 (125 mL) → will be reabsorbed almost completely except for .5-2 mL → will then enter the peritubular capillaries with all substance that our body needs and have been reabsorbed

while the 4/5 that are in the peritubular capillaries from the begining will undergo secretion

filtration fraction = GFR / effective renal plasma flow

plasma يُرشح من البلازما

125 / 625 = 20% (1/5)

functions of the kidney → filtration
Reabsorption
Secretion

filtration is the most important function → if there is no filtration there will be no Reabsorption and secretion

Secretion vs. Excretion

↓ ↓

Renal tubule Kidney

Autoregulation of renal blood flow →

↑ BP → Intrensic myogenic response

↳ will cause stretching in afferent arterioles → smooth muscles of the kidney vessels only will undergo vasoconstriction

↑ pressure → ↑ Resistance

$F = P/R$ → flow will be constant.

at low pressure → tubuloglomerular feedback → $P\downarrow$ → Juxtaglomerular cells will release renin

dilation of afferent

Constriction of efferent.

← Macula densa will have less NaCl → will induce renin release.

Glomerulus VS. peritubular capillary

↓

- filtration
- high pressure in the glomerulus ≈60 mm Hg (Highest capillary pressure in the body). Why ?!

Renal artery is direct branch of the aorta.

- Afferent → short straight
- Efferent

vasa recta → capillary that deals with loop of henle in Juxtamedullary nephrons only. (recieves 1-2% of blood)

4/5 of the renal plasma flow

↓

will reabsorb 124 mL of the filtered plasma (low pressure)

≈ 13 mm Hg