Overview of Kidney

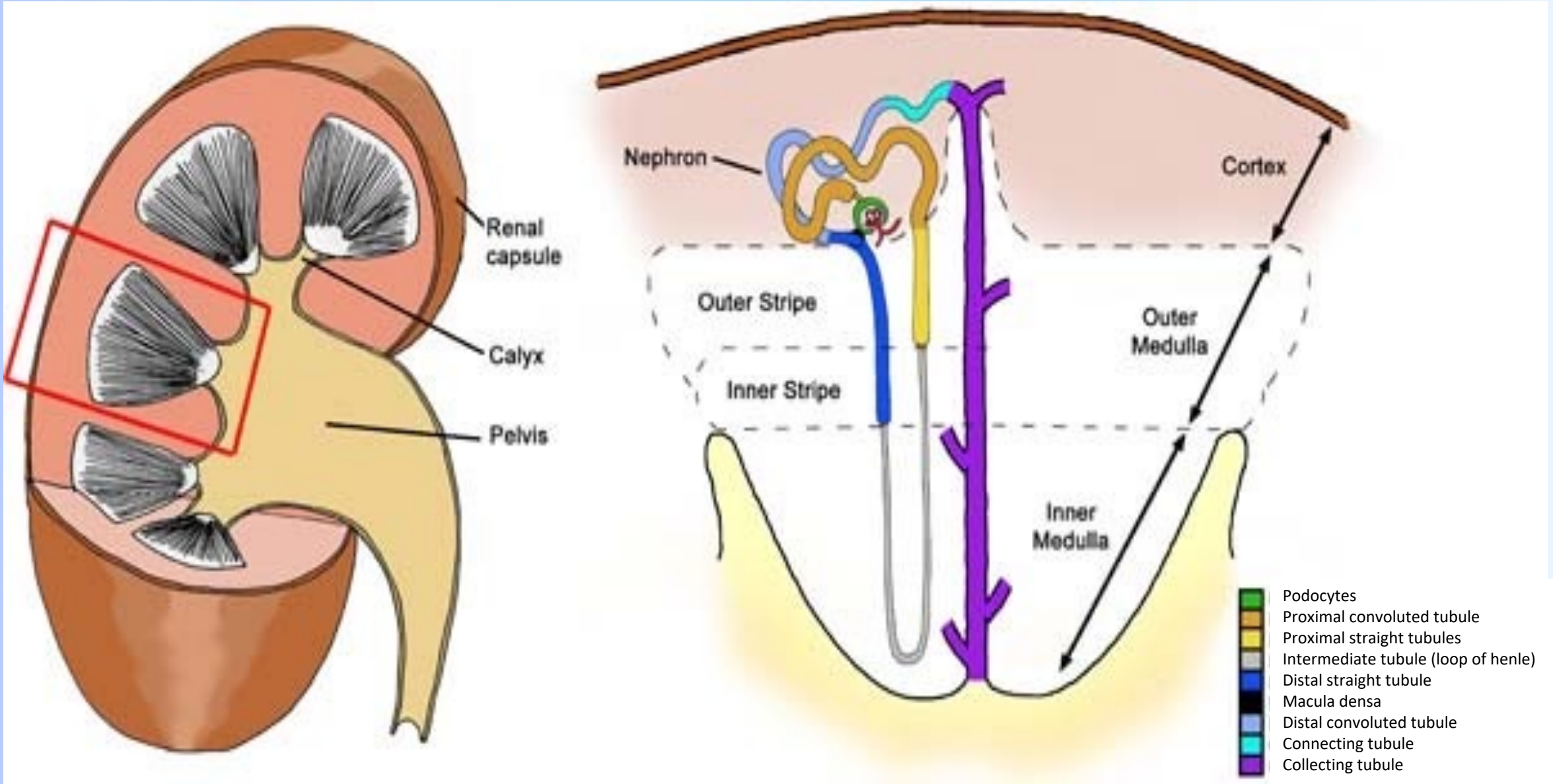
By Adriana Nudga

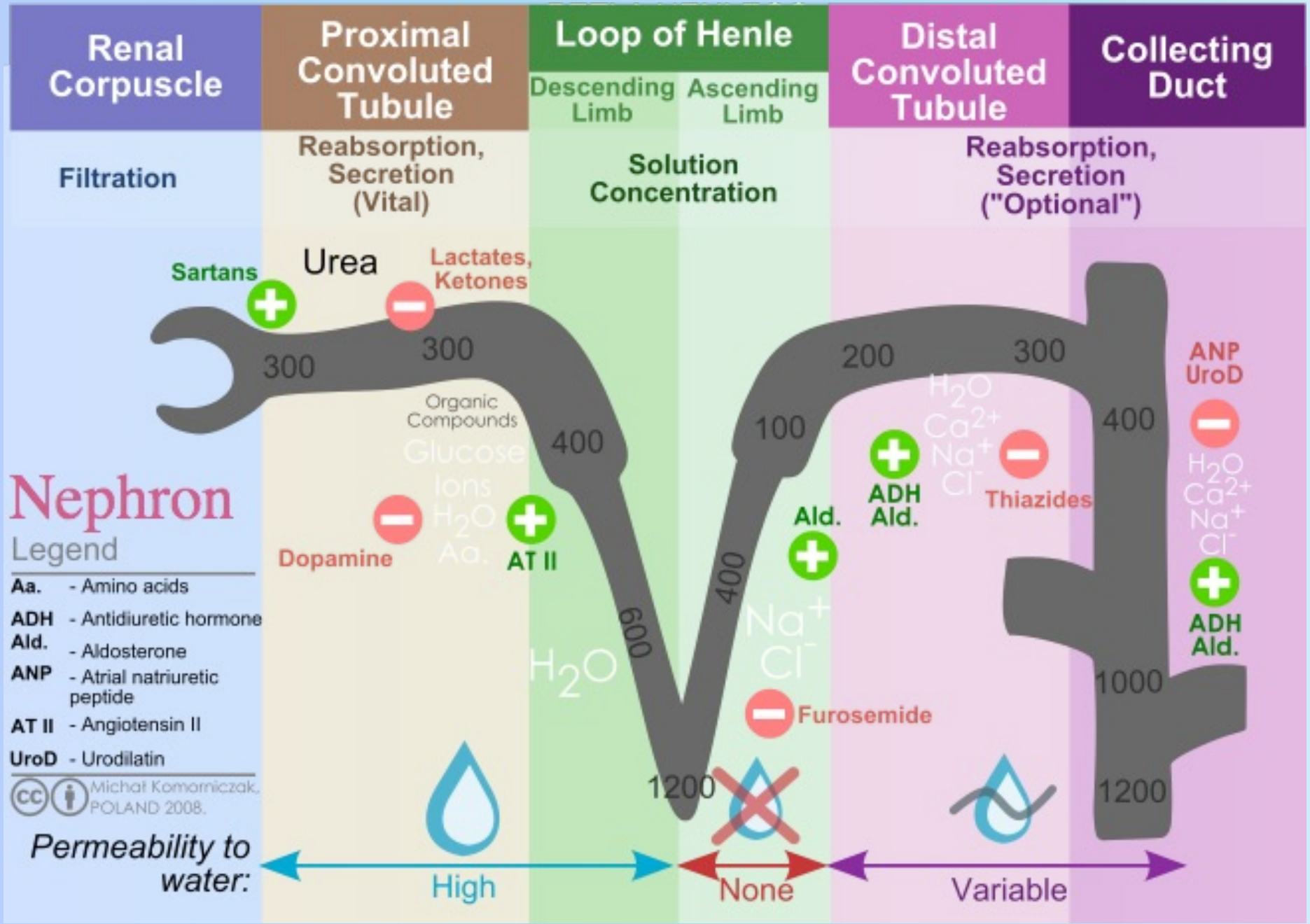
Check list

- ❑ Kidney overview
- ❑ Osmolarity
- ❑ Urine concentration
- ❑ RAAS

Kidney functions

- Excrete waste products: urea, uric acid, creatinine
- Water and electrolytes balance
- Acid/base balance
- Secrete:
  - Hormone: erythropoietin (blood cells growth)
  - Enzyme: Renin (convert angiotensinogen to angiotensin 1)
- Hydroxylate 25-hydroxy-vit D to active form vitamin D (1,25 dihydroxy-vit-D)

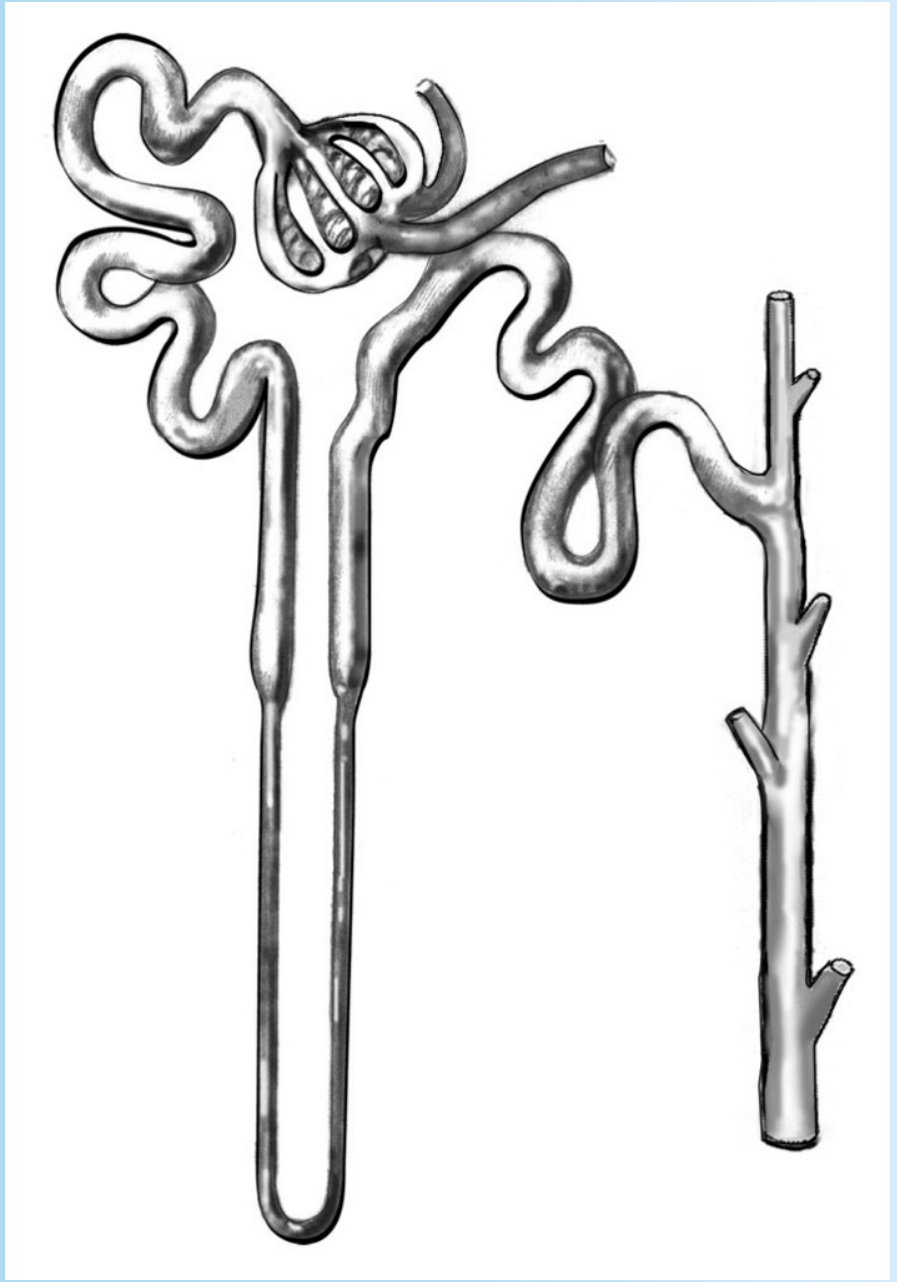

Renal capsule
Calyx
Pelvis
Nephron
Cortex
Outer Stripe
Outer Medulla
Inner Stripe
Inner Medulla
Podocytes
Proximal convoluted tubule
Proximal straight tubules
Intermediate tubule (loop of henle)
Distal straight tubule
Macula densa
Distal convoluted tubule
Connecting tubule
Collecting tubule


Renal Corpuscle
Proximal Convoluted Tubule
Loop of Henle
Descending Limb
Ascending Limb
Distal Convoluted Tubule
Collecting Duct
Filtration
Reabsorption, Secretion (Vital)
Solution Concentration
Reabsorption, Secretion ("Optional")
Sartans
Urea
Lactates, Ketones
300
300
Organic Compounds
Glucose
Ions
H_2O
Aa.
400
600
1200
Dopamine
AT II
Ald.
400
100
200
300
400
1000
1200
ADH
Ald.
Thiazides
ANP
UroD
ADH
Ald.
Furosemide
Nephron
Legend
Aa. - Amino acids
ADH - Antidiuretic hormone
Ald. - Aldosterone
ANP - Atrial natriuretic peptide
AT II - Angiotensin II
UroD - Urodilatin
Michał Komorniczak, POLAND 2008.
Permeability to water:
High
None
Variable

The Nephron

4 functions:

- Filtration
  - Blood
  - Starling forces
  - GFR
- Reabsorption
  - Tubular fluid -> blood
  - Solutes + water
- Secretion
  - Blood -> tubular fluid
  - Active transport
- Excretion
  - Urine
  - Filtered and not reabsorbed



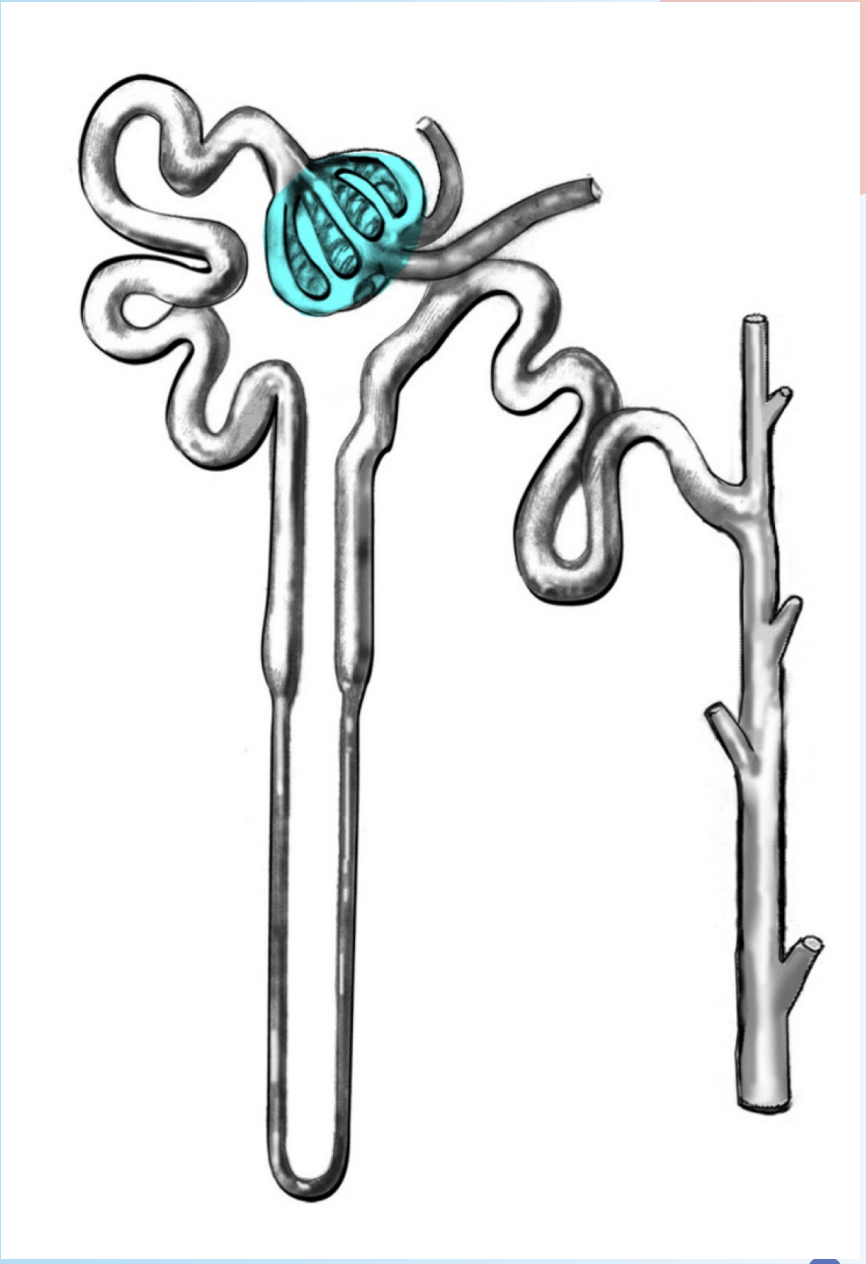
Renal capsule

Afferent
Effernet blood
Filtration
Substances that pass through into the tubular fluid:

glucose
AA
water
salts (

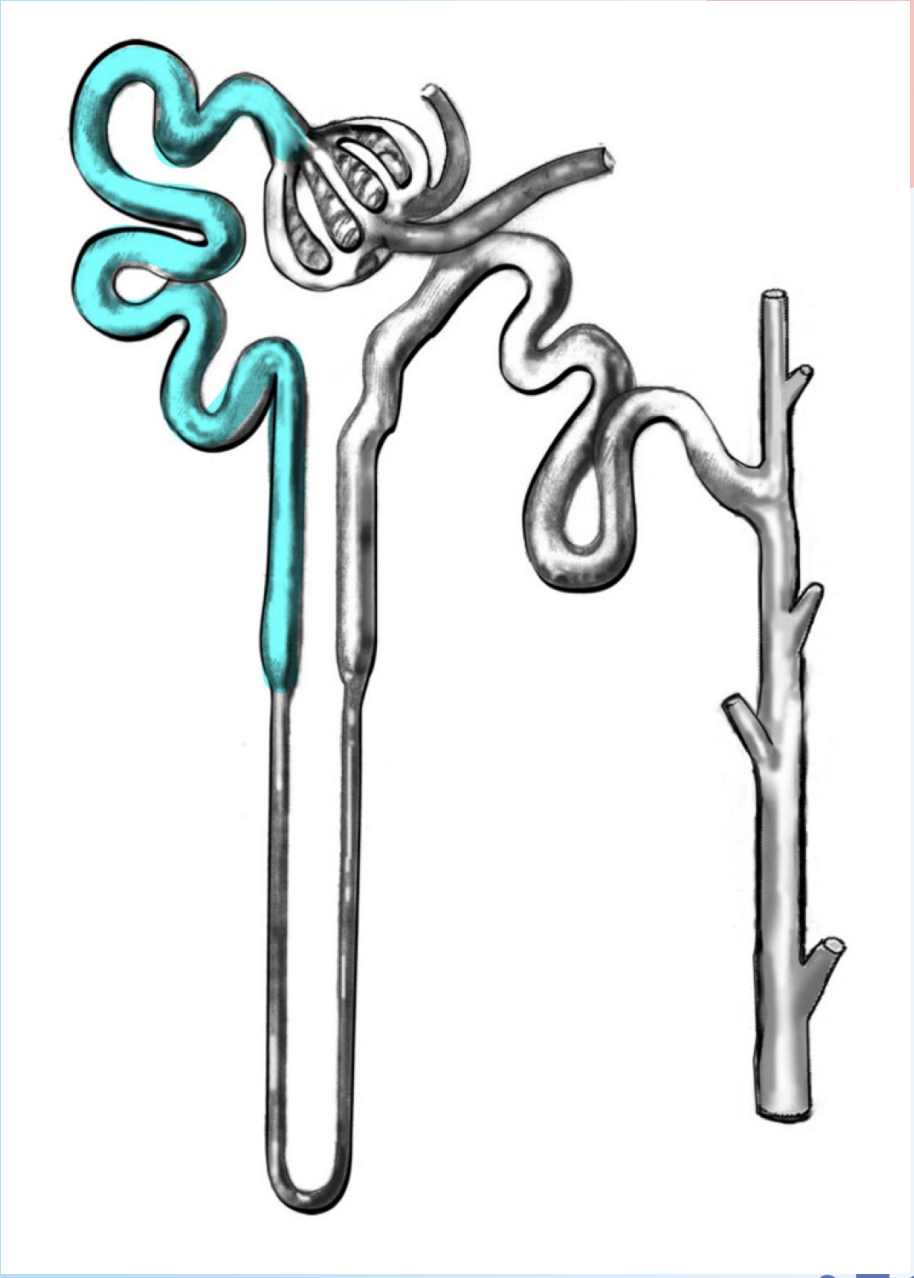
Small solutes are filtered more than big solutes

- Negatively charged endothelium
- Repels negatively charged solutes, atracts positevely charged solutes

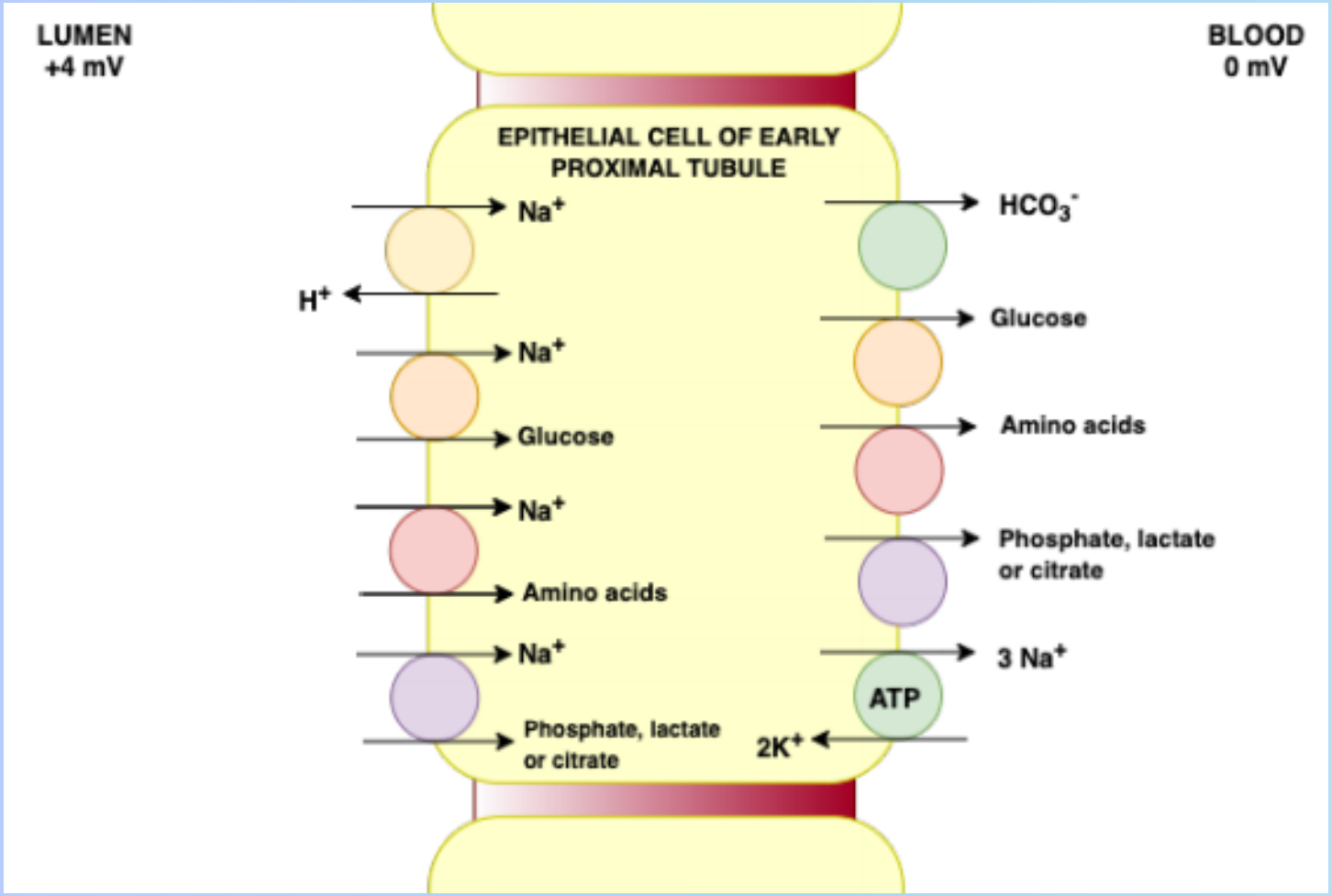


Proximal tubule

- Resorption of water (70-80%)
- Reabsorption Na+ (around 2/3 of filtered Na+)
- Resorption of ions (Na+, Cl-), glucose, amino acids
- Bicarbonate reabsorption
- Membrane transporters
- Resorption of some metabolites and drugs
- Secretion of ammonia, urea, exogenous compounds

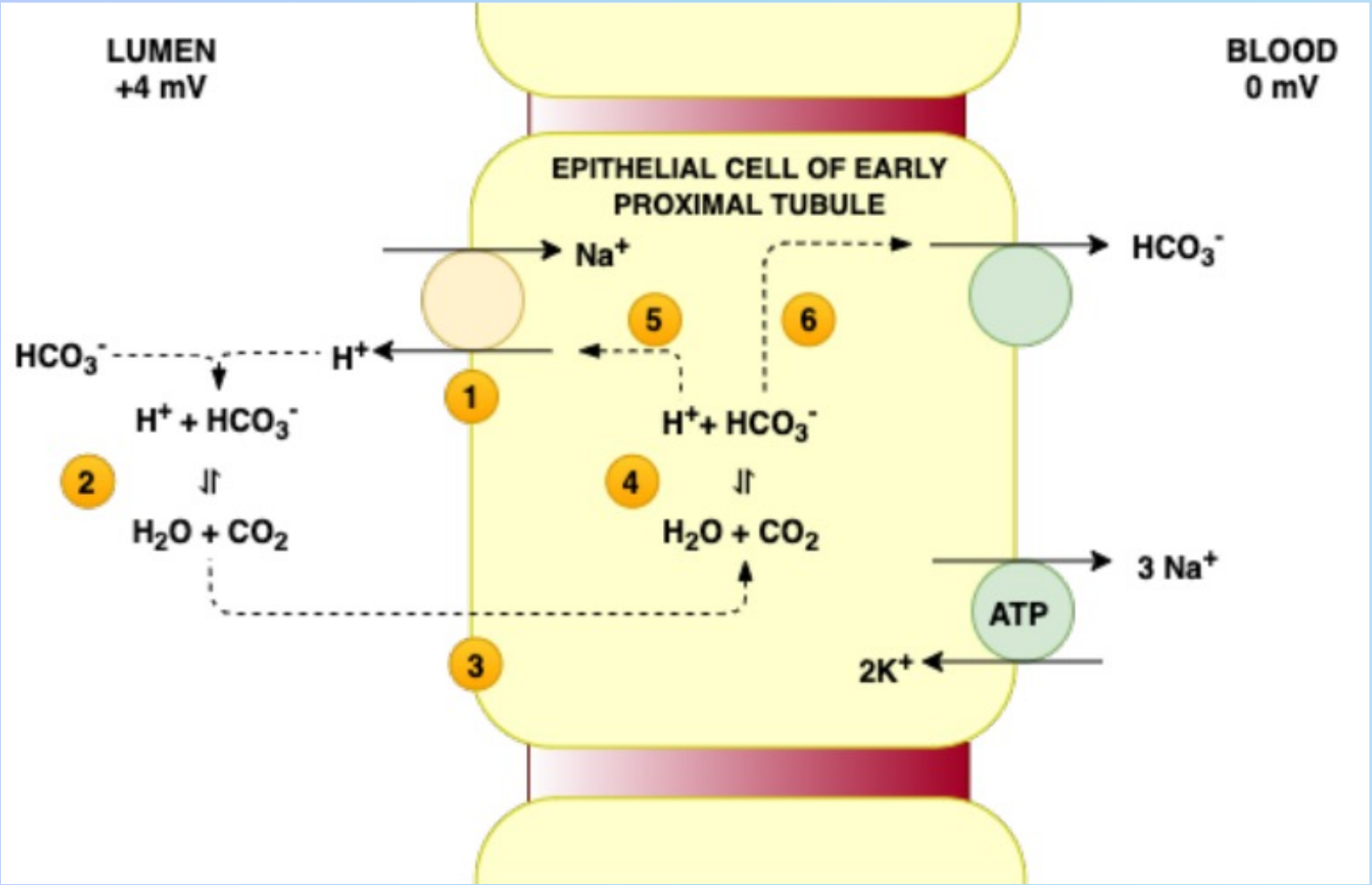


Transports in proximal tubule



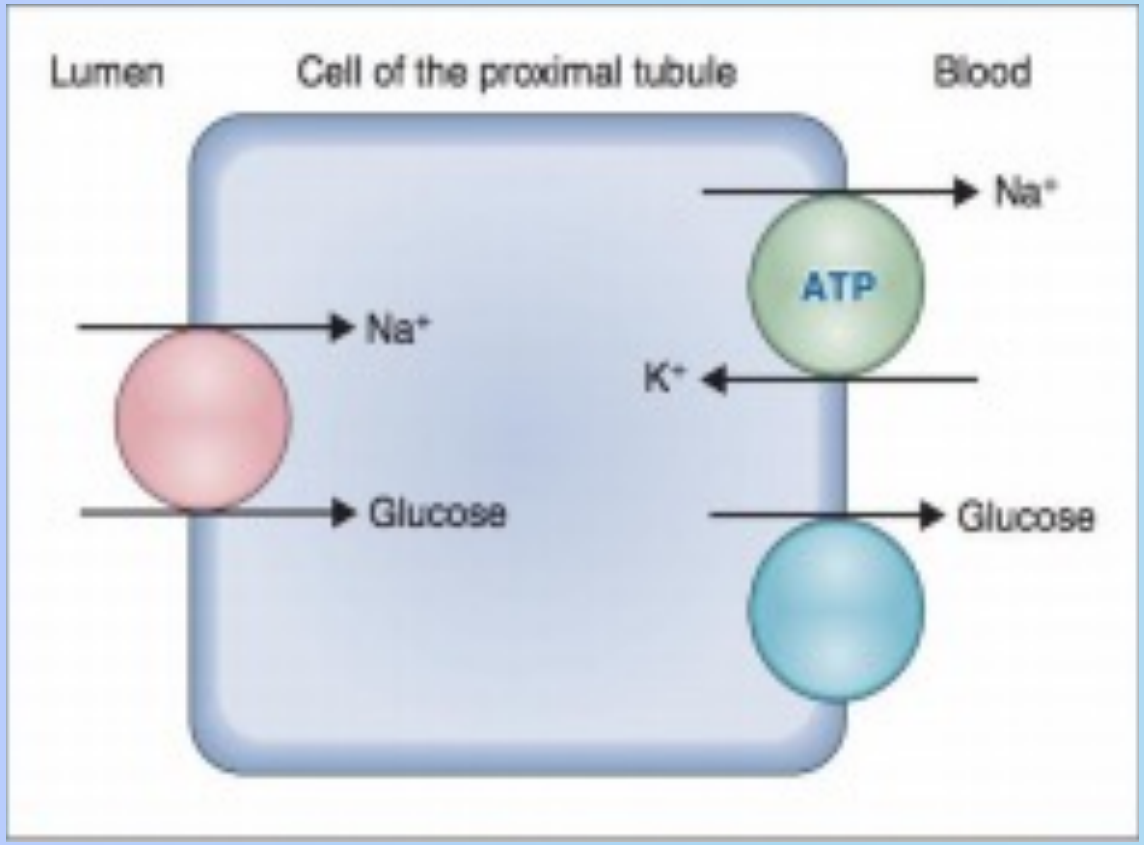
- 100% of filtered glucose
- 100% of amino acid
- 85% of filtered bicarbonate
- Most of phosphate, citrate and lactate
- Extensive sodium reabsorption

Transport HCO3



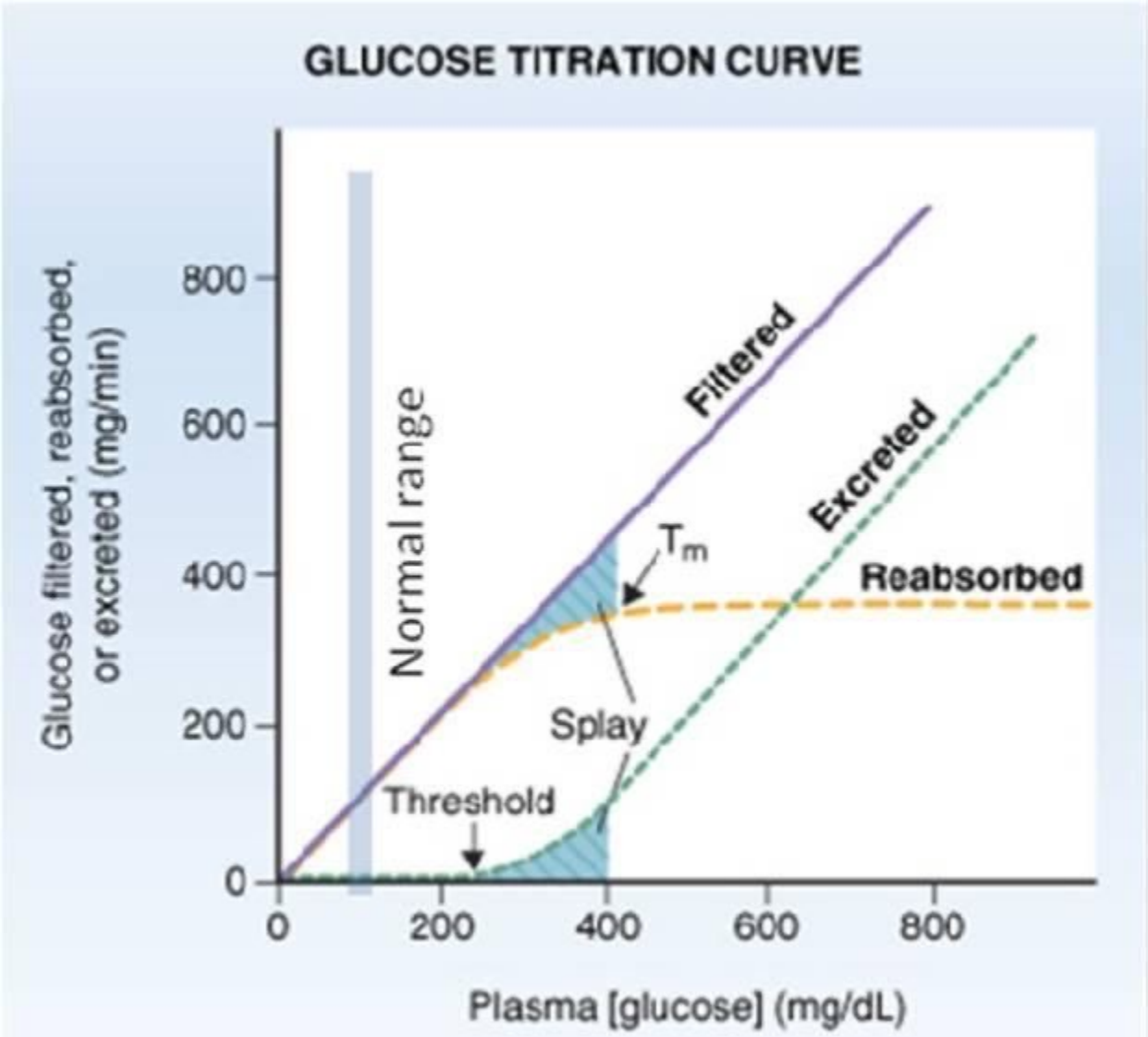
1. Sodium (Na+) is absorbed from lumen in exchange for hydrogen (H+)
2. Hydrogen combines with bicarbonate – creating water and CO2
3. Water and CO2 diffuses back into the epithelial cell of the proximal tubule
4. Water and CO2 is then reconverted to H+ and HCO3 –
5. H+ is transported to the lumen via the Na+ -H+ exchanger
6. HCO3 – is reabsorbed to blood via facilitated diffusion

Glucose



- Na2 -Glucose transporter (SGLT)
- secondary active transport
  - depends on luminal Na+
  - stimulated by [Na+]
  - linked to uptake of Na+
  - depends on rate of ATP production
- facilitated diffusion
- GLUT 1 and GLUT 2

Glucose titration curve



- Normal glucose lv. and proper functioning kidneys show no glucose in urine
- More glucose in blood = More glucose is filtered
- Threshold at 200mg/dL (threshold is level at which glucose starts to be seen in urine)
- Splay (wiggle room for threshold cause some nephrons reach Tm faster than others)
- Fully saturated at 350mg/dL

Clinical: Glucosuria

Tm = maximal reabsorption rate GLU = carriers of GLU are saturated

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Loop of Henle

Descending limp

highly permeable to water via AQP1 channels.

Uses counter current multiplication (https://www.youtube.com/watch?v=cYyJF_aSC6o)

Very low amounts of urea, Na^+ and other ions reabsorbed.

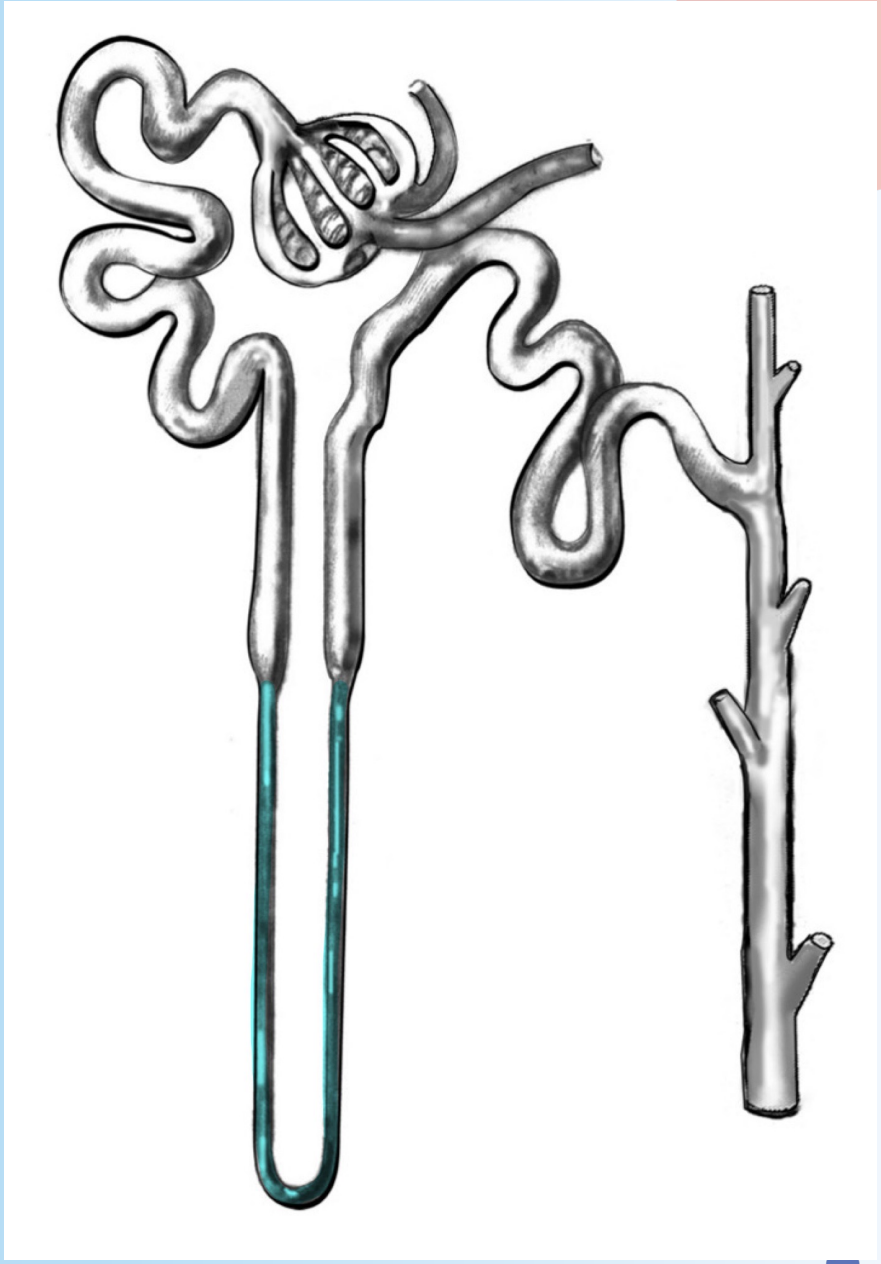
Ascending limp

2 parts thin and thick
Impermiable to water

Thin:
Passive reabsorption Na+ interstitium becomes concentrated with ions, increasing the osmolarity

Thick:
Na+ reabsorption is active - the driver is the Na^+/K^+ ATPase

Na+/K+/Cl- simport into the



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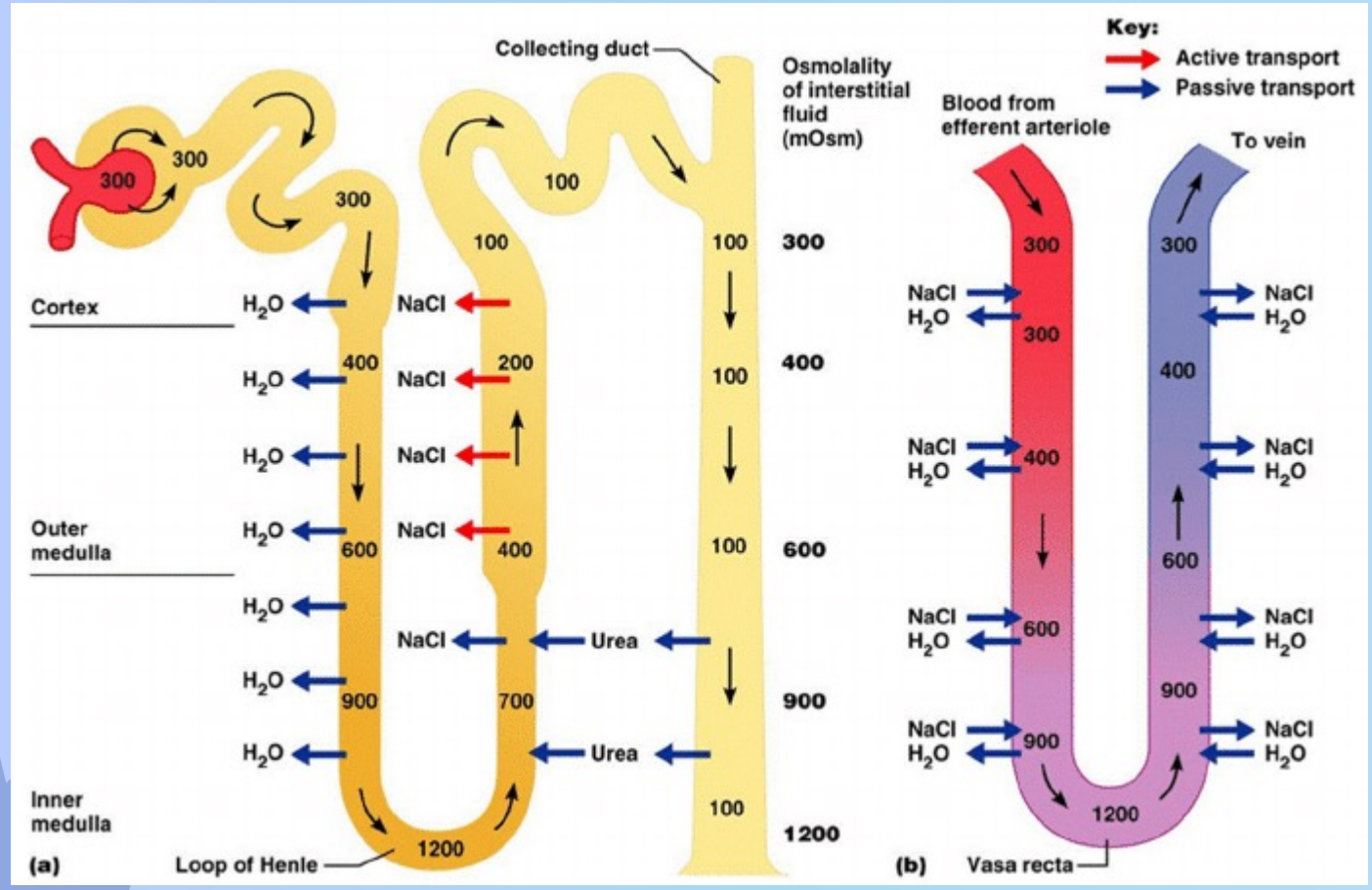
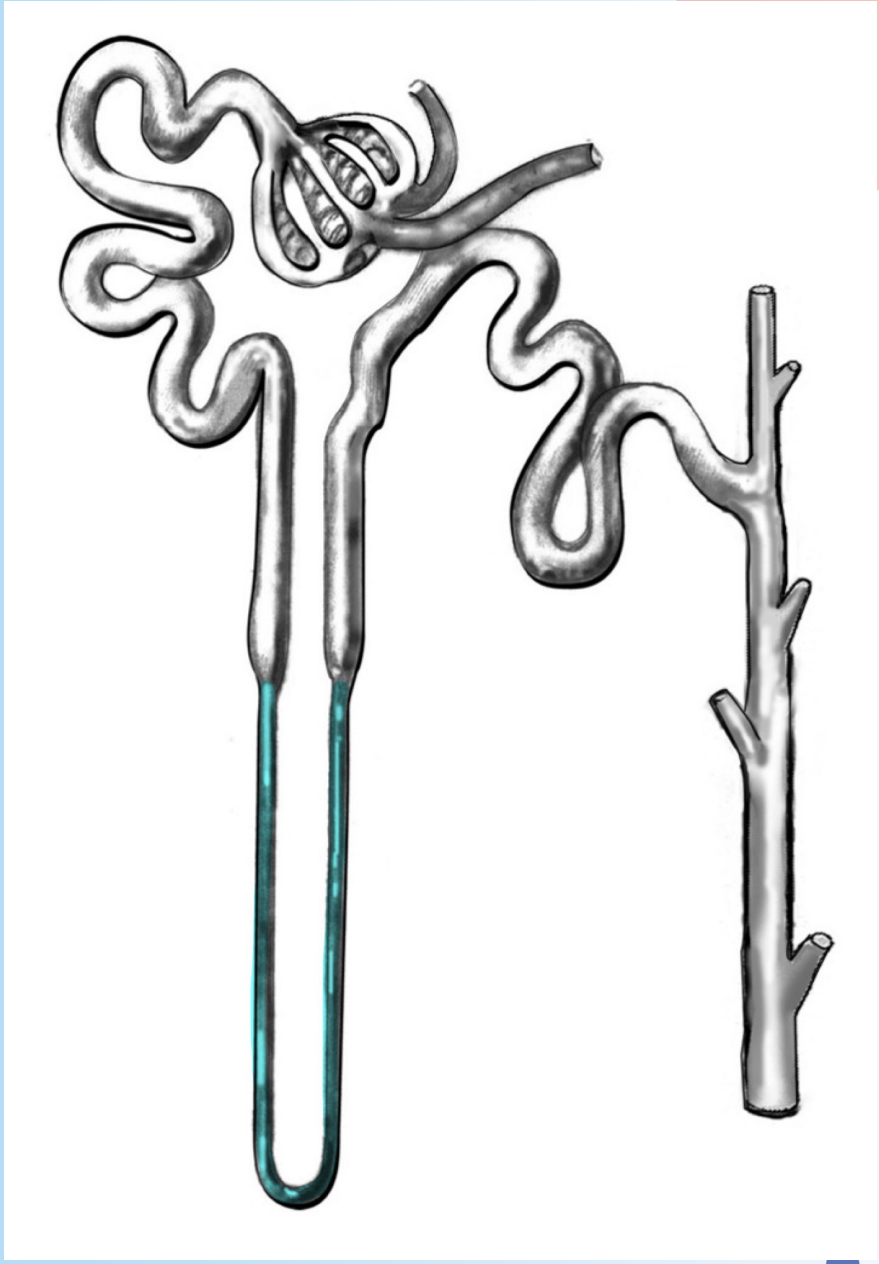
counter current multiplication

Remember osmolarity: water moves from area of low solute to high solute. (watlower osmotic pressure to higher osmotic pressure.)





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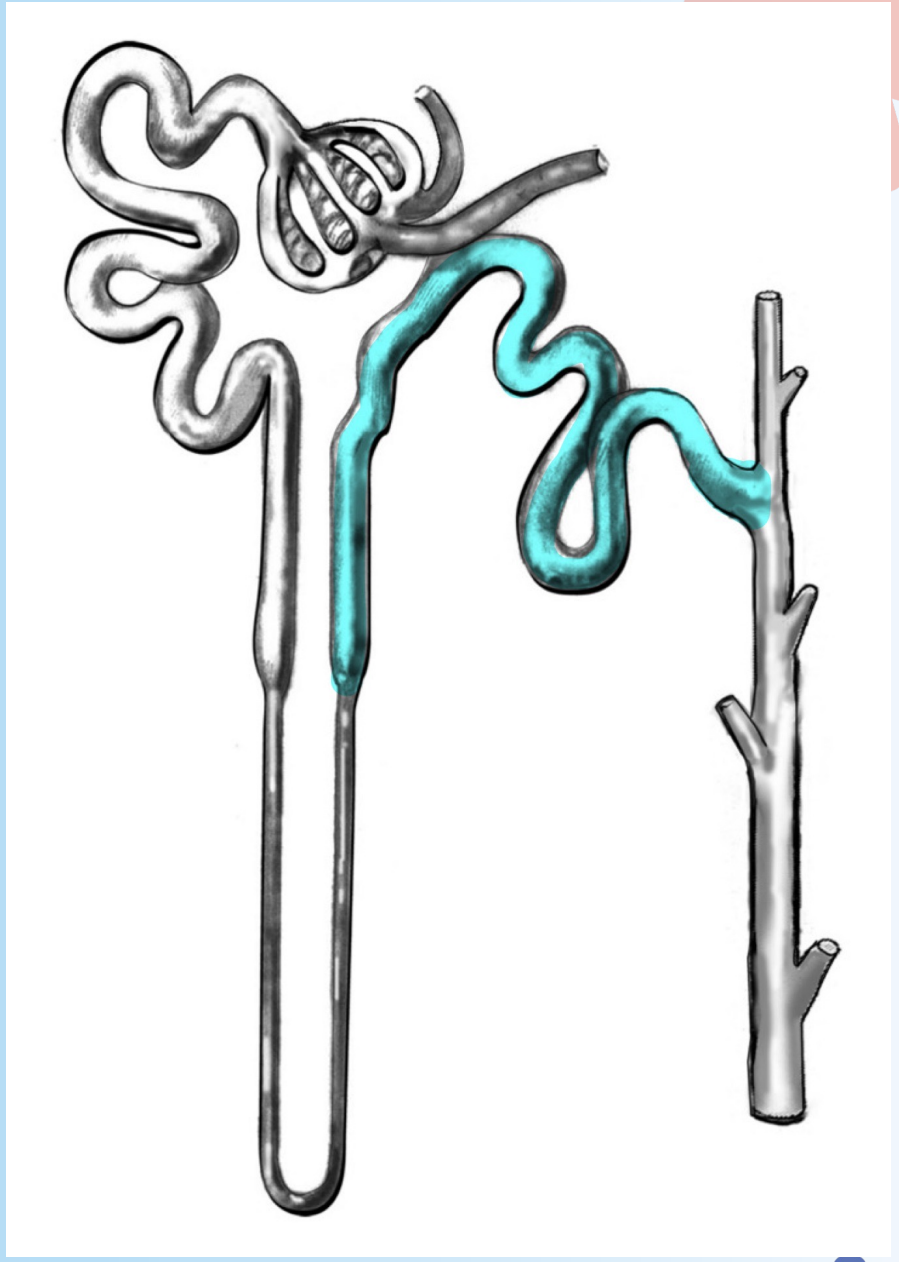
Thin descending limb	Thin Ascending limb	Thick Ascending limb
Permeable to water and small solutes (as NaCl and urea)	Permeable to NaCl Impermeable to water	Net reabsorption of Na+ , K+ and ClImpermeable to water
Passive diffusion of solutes	Passive diffusion of solutes	Active reabsorption by Na+ - K+ -2Clcotransporter.
Water moves out, solutes move in	Solutes moves out, water remains in the lumen	Solute is reabsorbed, water remains in the lumen
Filtrate becomes more hyperosmotic as it moves down the thin descending limb	Filtrate becomes hypoosmotic as it moves up the thin ascending limb	Tubular fluid become more diluted

Distal tubule

- Reabsorption of Na+, Cl-
- Secretion of K+, H+
- Controlled by aldosterone
- Acidifies urine



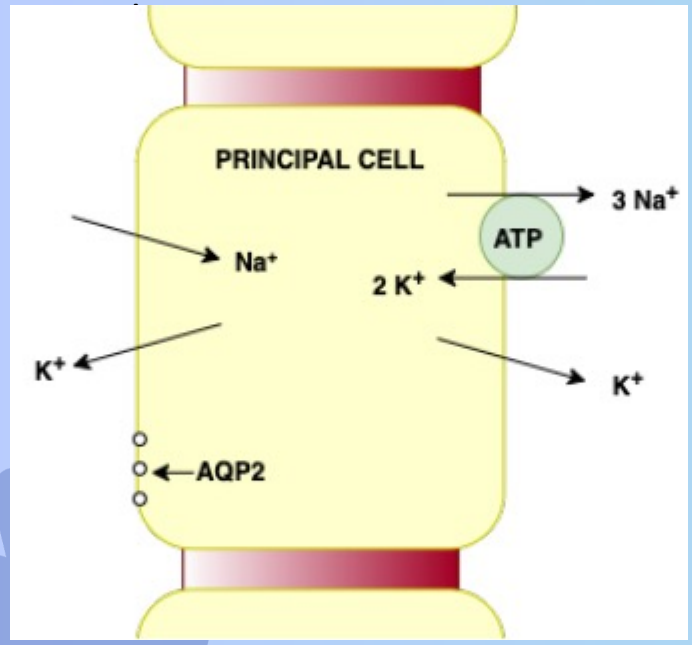
Collecting duct

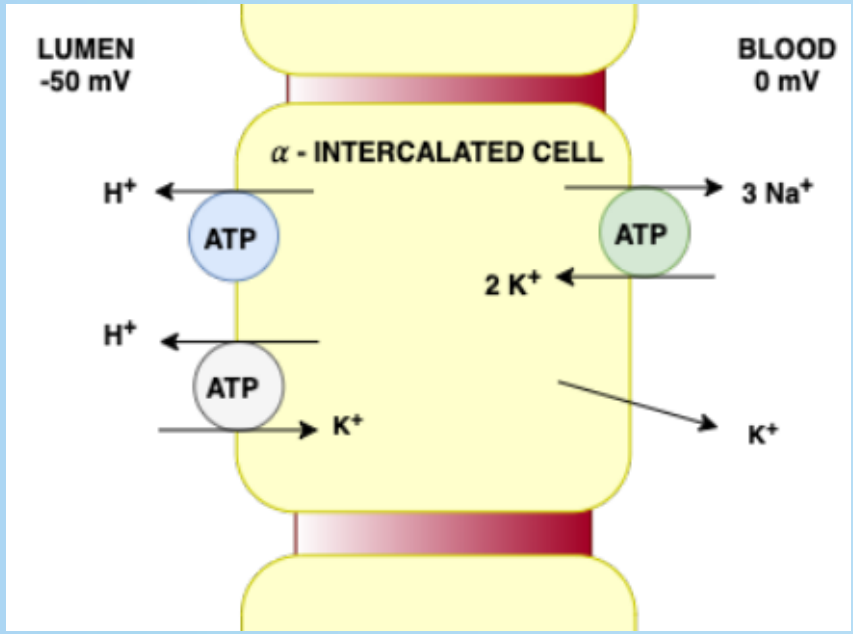
Principal cells

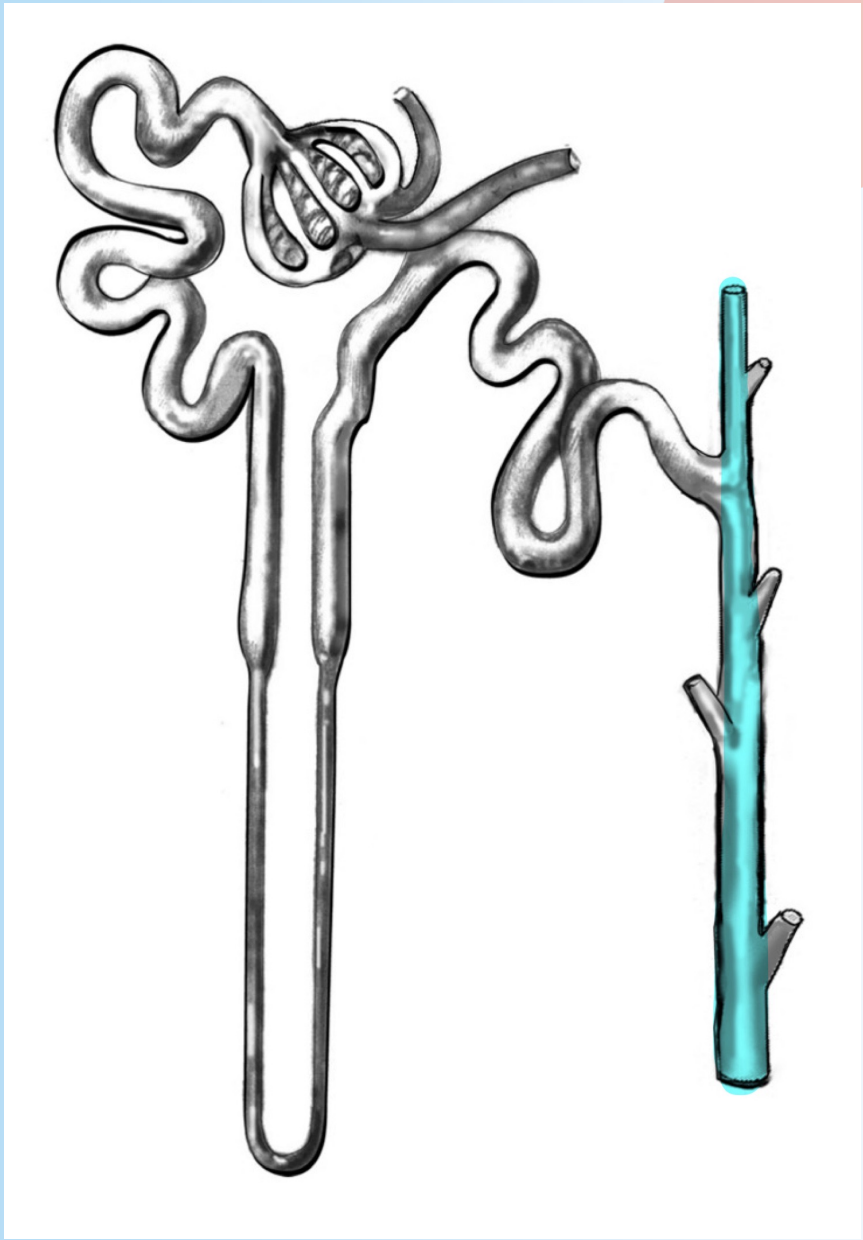
- Reabsorption Na+ via Epithelial Na+ channels
- Secretion K+
- H2O reabsorption (AQP2)
- Na^+/K^+-ATPase pumps basal

Intercalated cells

a-intercalated cells:
- K+ reabsorption
- H+ secretion







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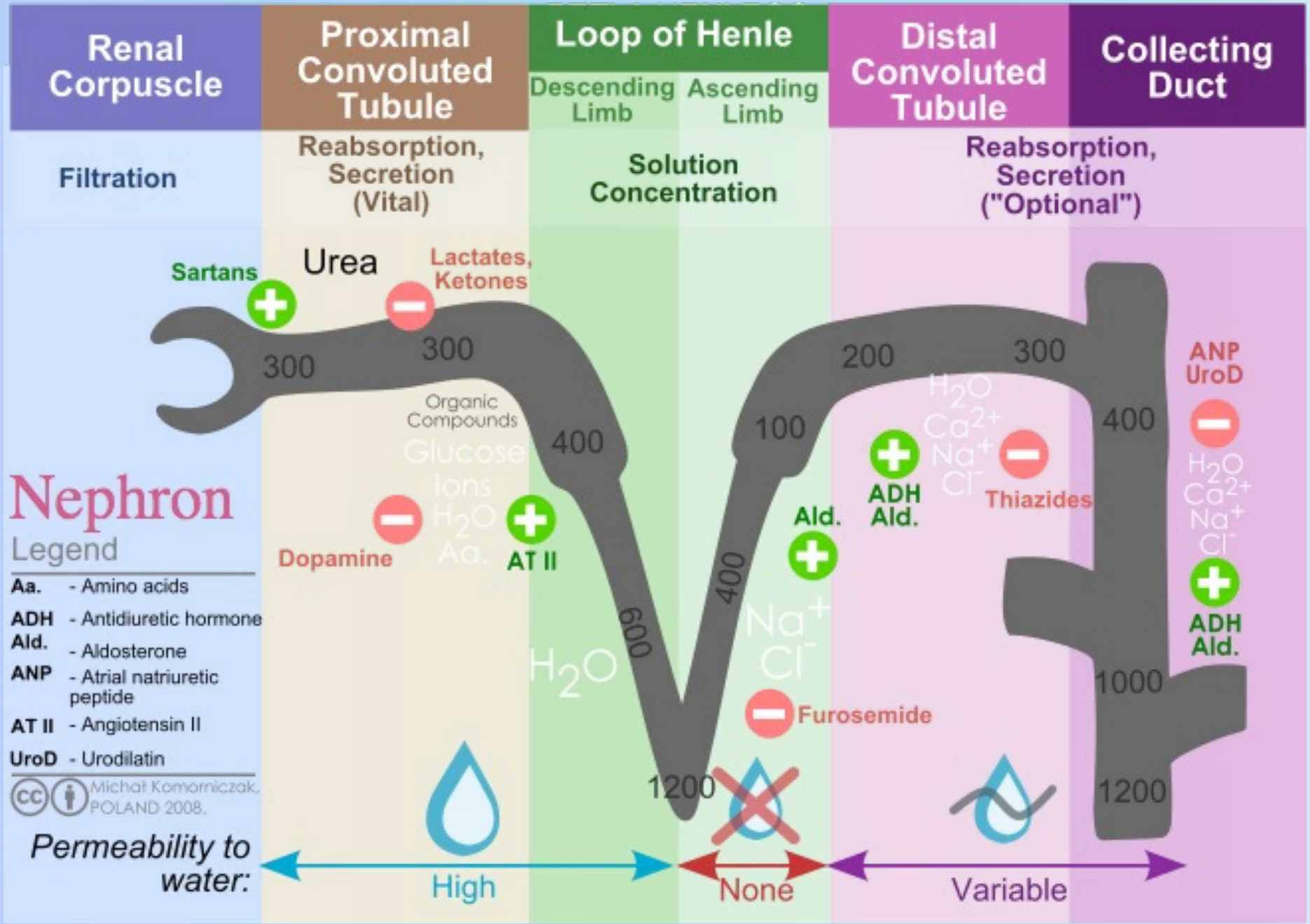
Segment/cell type	Major functions	Water permeability
proximal tubule	Isosmotic reabsorption of solute and water	Permeable
Thin descending limb	Reabsorption H2O and NaCl from urine	Permeable
Thin ascending limb	Reabsorption of NaCl Dilution of tubular fluid Single effect of countercurrent multiplication Reabsorption of Ca2+ and Mg2+	Impermeable
Early distal tubule	Reabsorption of NaCl Dilution of tubular fluid	Impermeable
Late distal tubule and collecting ducts		
Principal cells	Reabsorption of NaCl K+ secretion Regulate water reabsorption	Permeable with ADH present
α-intercalated cells	K+ reabsorption H+ secretion	Not relevant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Ions
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Woo-clap!!

WEB

1. Connect to www.wooclap.com/ZGZYXK
2. You can participate

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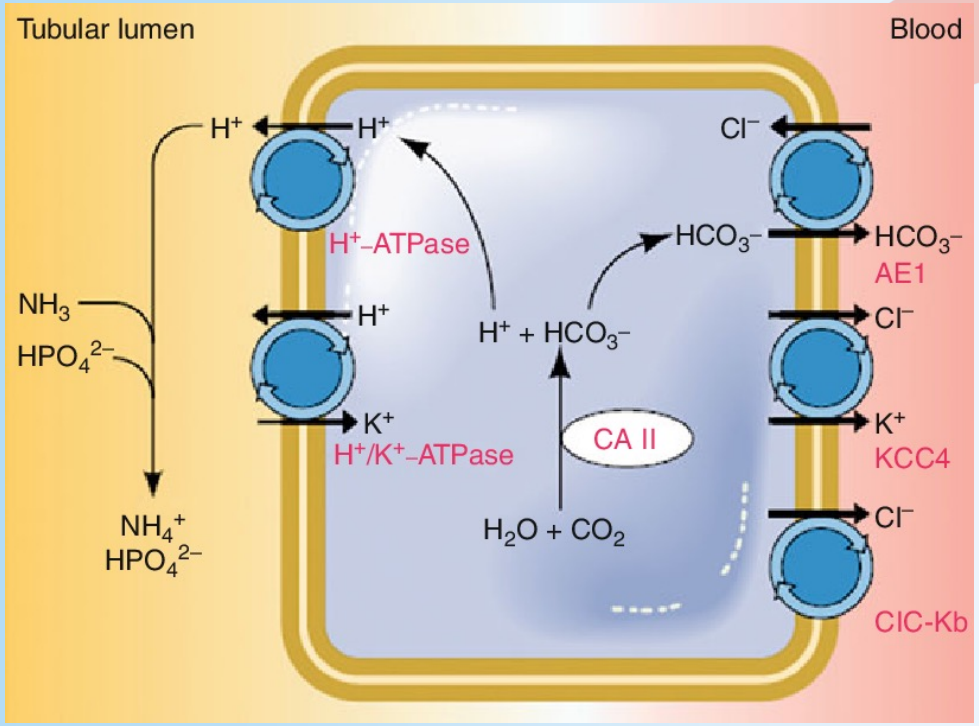
Urine concentration

- The nephrons of the **kidneys** process blood and create **urine** through a process of filtration, reabsorption, and secretion.
- **Urine** is about 95% water and 5% waste products.
- Nitrogenous wastes excreted in **urine** include urea, creatinine, ammonia, and uric acid.
- These wastes come from PT cells in response to acid/base balance.



Proximal tubule

- •Resorption of water (70-80%)
- •Reabsorption Na+ (around 2/3 of filtered Na+)
- •Release ammonia

Loop of henle

- •descending part: h2O reabsorption
- •ascending part: Na+, NaCl reabsorption

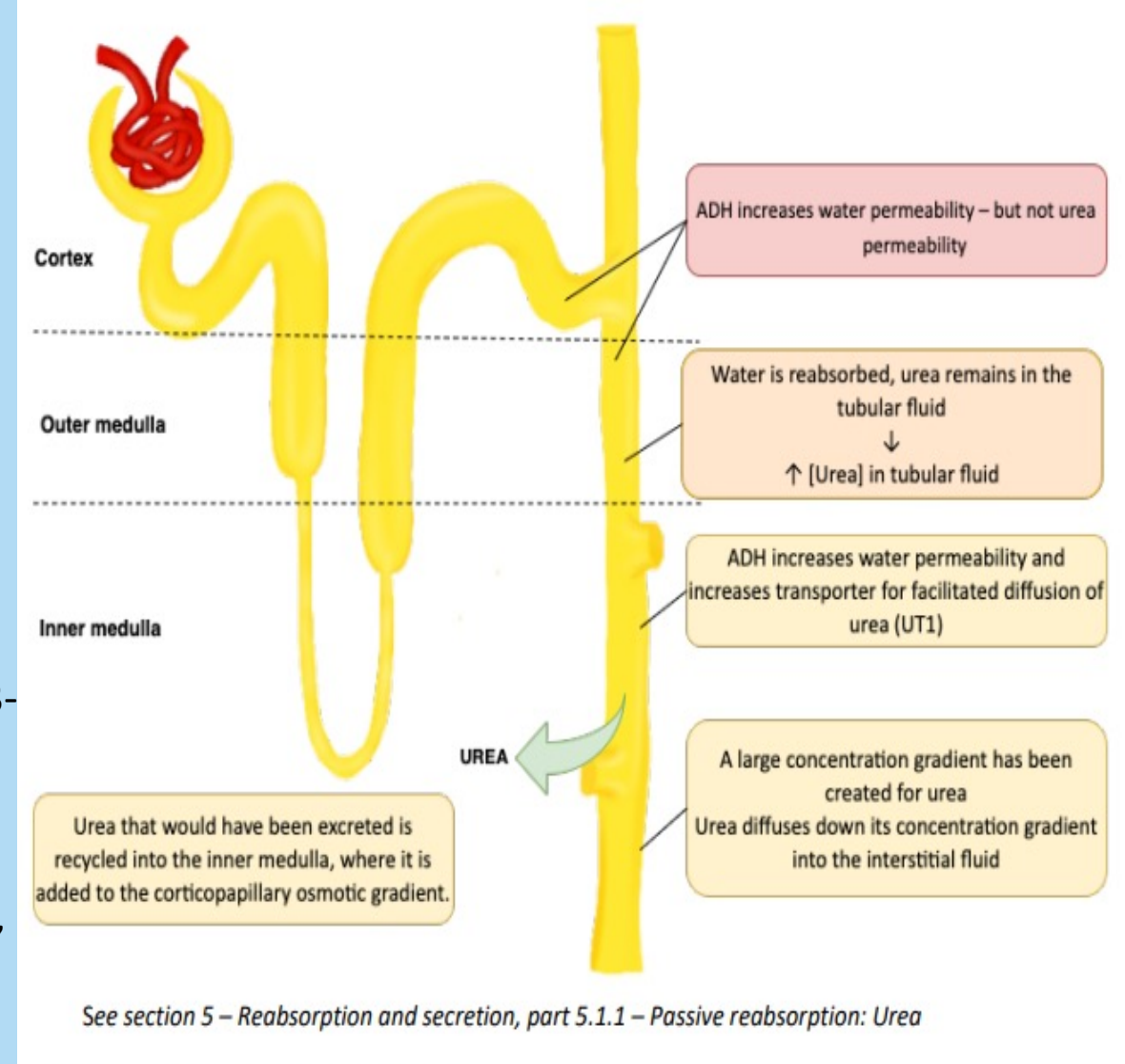
Distal tubule

- •Reabsorption of Na+, Cl-
- •Secretion of K+, H+
- •Acidifies urine via reabsorbing portion of the filtered HCO3- (base) from PT

Collecting duct

- •Resorption of water via Membrane channels (aquaporins), mediated by ADH
- •Intercalated cells make ammonium
- •Principal cells: Na+ channels, K+ channels H2O reabsorption (AQP2)

End : 95% water and 5% waste products.



RAAS

Renin-angiotensin-aldosterone system

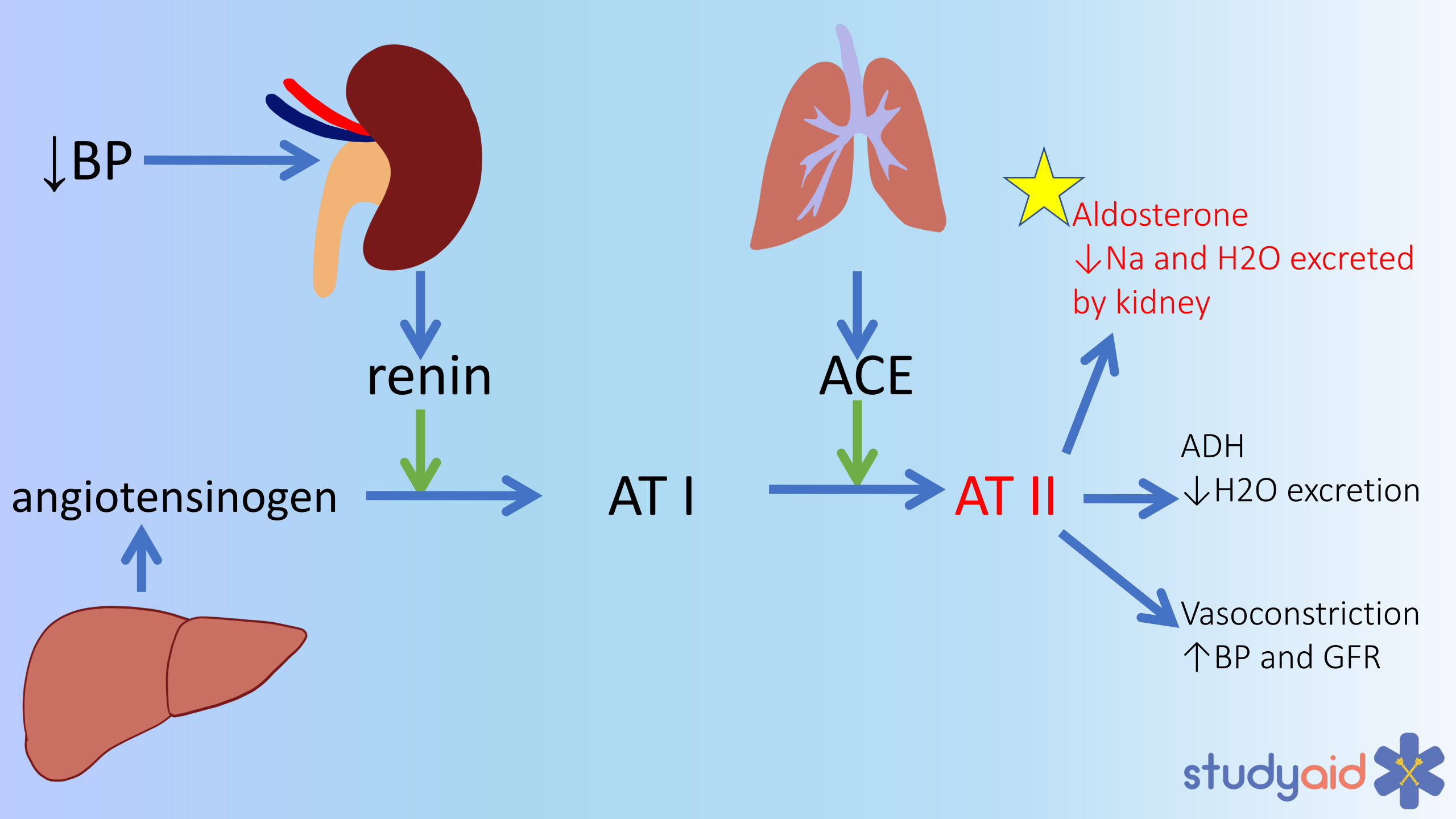
Blood Pressure Regulation

Baroreceptor Reflex

- Neurally mediated
- Fast
- Respond to change in Arterial pressure (Pa)

RAAS

- Hormonally mediated
- Slow
- Respond to change in Arterial pressure (Pa)


↓BP
renin
angiotensinogen
AT I
ACE
AT II
Aldosterone
↓Na and H2O excreted by kidney
ADH
↓H2O excretion
Vasoconstriction
↑BP and GFR

RAAS

1. Kidney sense low blood pressure
2. Release renin
3. Renin converts agiotensinogen -> angiotensin 1
4. ACE (angiotensin–converting enzyme) converts angiotensin 1 -> angiotensin 2
5. Angiotensin 2 stimulates aldosterone, ADH and thirst
6. Aldosterone cause kidney reabsorption of Na+, ADH increases water uptake
7. Water follows sodium
8. Blood volume increases, pressure increases

Woo-clap!!

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Good luck :)

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