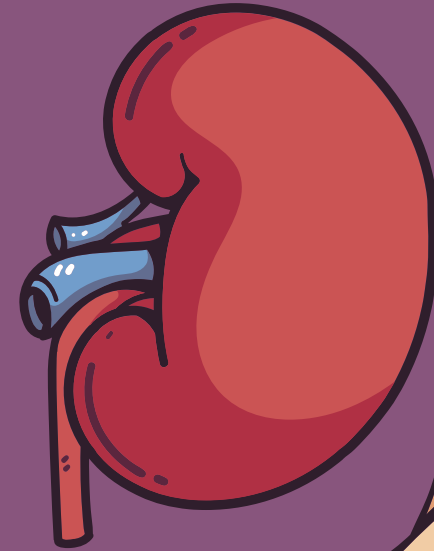


THE KIDNEY: From Structure to Symphony

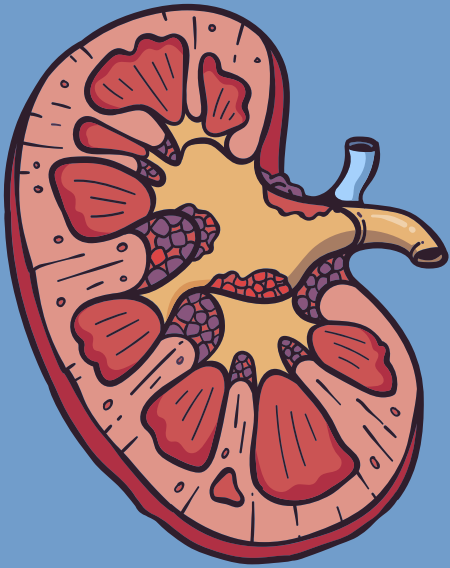
Dr. Zubayer Al Alam
Lecturer
Department of Anatomy
Green Life Medical College

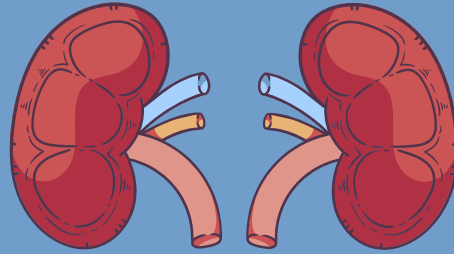


“WHY THE KIDNEY”

Contents we would like to discuss today:

- Embryology
- Gross Anatomy
- Structures
- Function
- Clinical Relevance



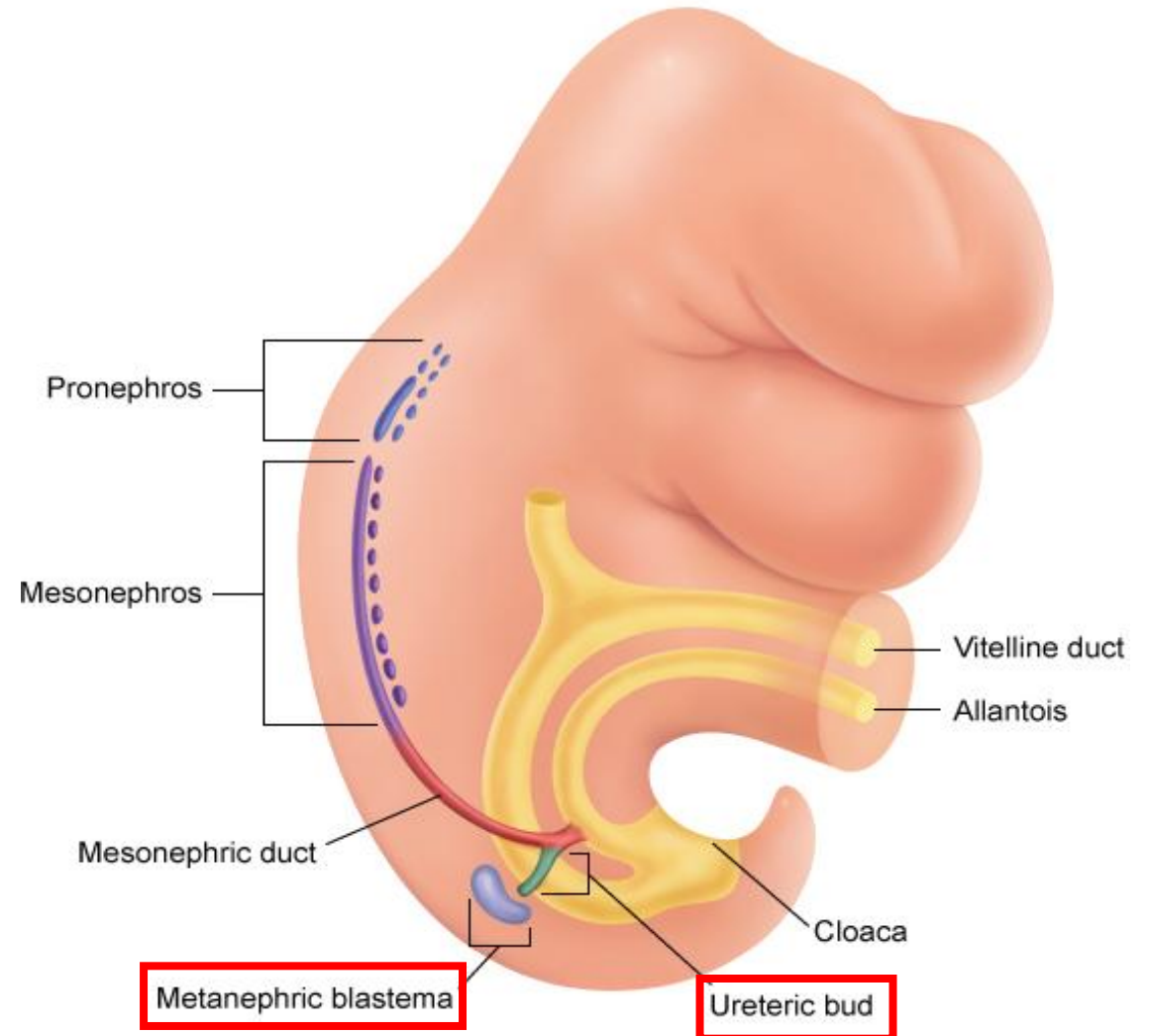


*“Anatomy is not merely the study of structures;
It is the foundation upon which we understand
function, disease and clinical medicine”*

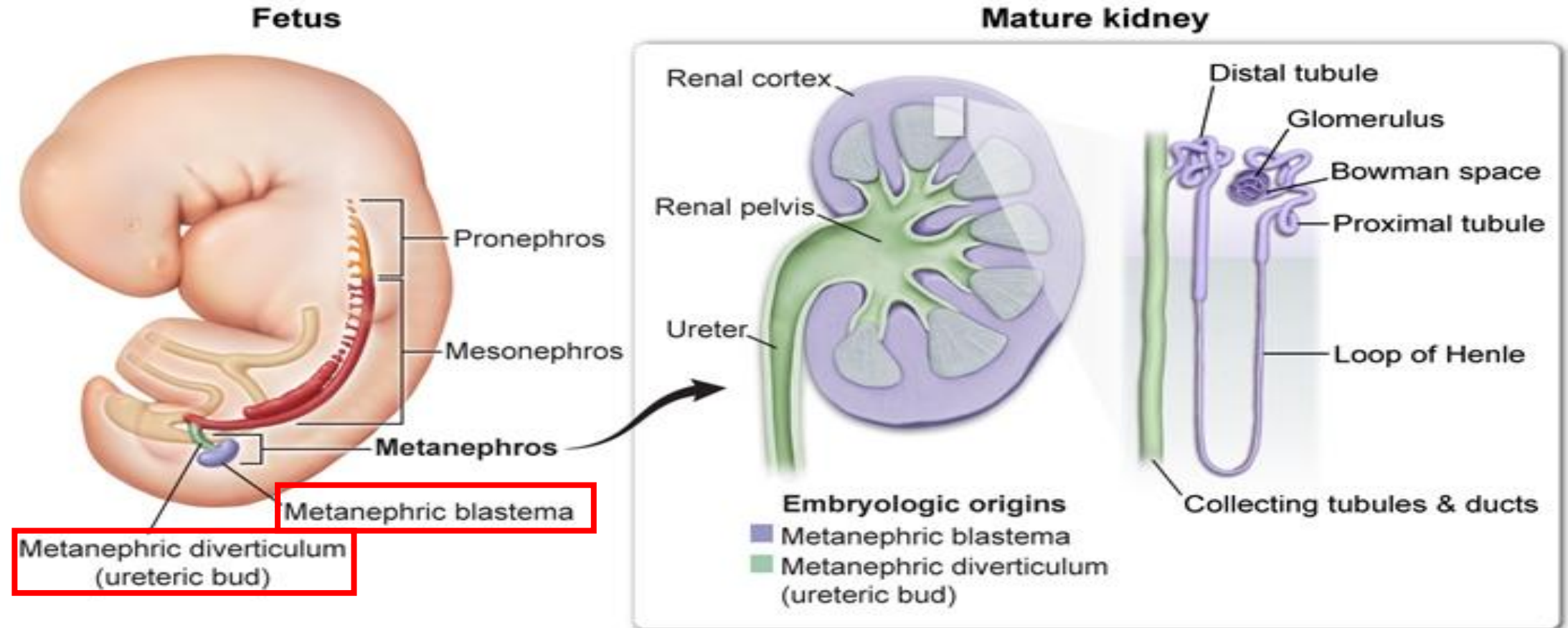


Development of Kidney

- Sequential Development
 - **Pronephros** (4th Week of IUL)
 - **Mesonephros** (Week 4th -8th)
 - **Metanephros** (5th Week onward)
- Two distinct components:
 - Ureteric Bud
 - Metanephric Blastema



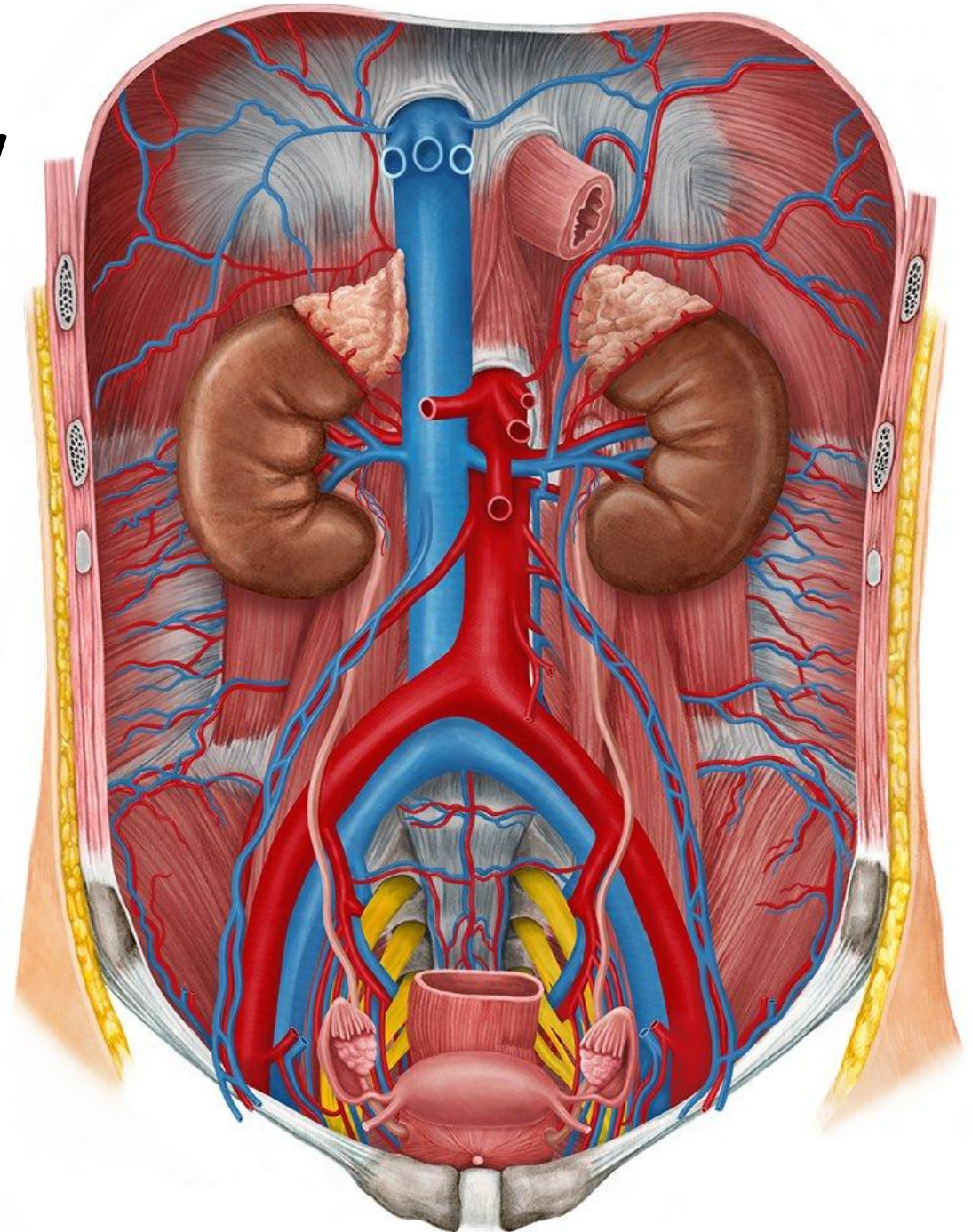
Embryology of Kidney (Contd.)



“Fetal kidney contributes to continuous amniotic-fluid turnover and volume maintenance”

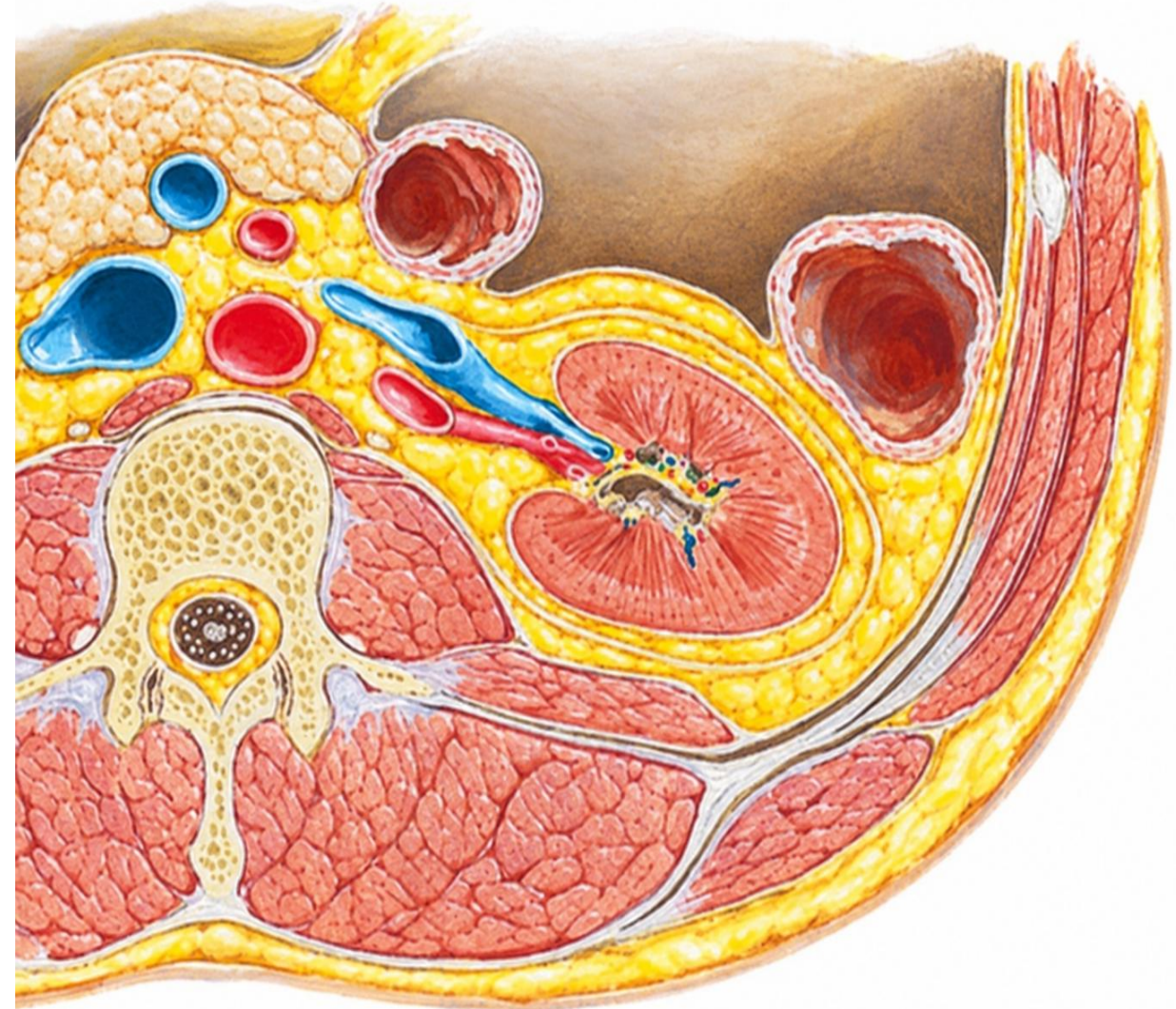
Gross Anatomy of Kidney

- Paired & **Retroperitoneal** organ
- Approximately **11*6*3 cm** in size
- Extends from **T12-L3 vertebrae**
- **Right kidney** lies slightly lower than left kidney
- The medial gateway of the kidney - **Renal Hilum**



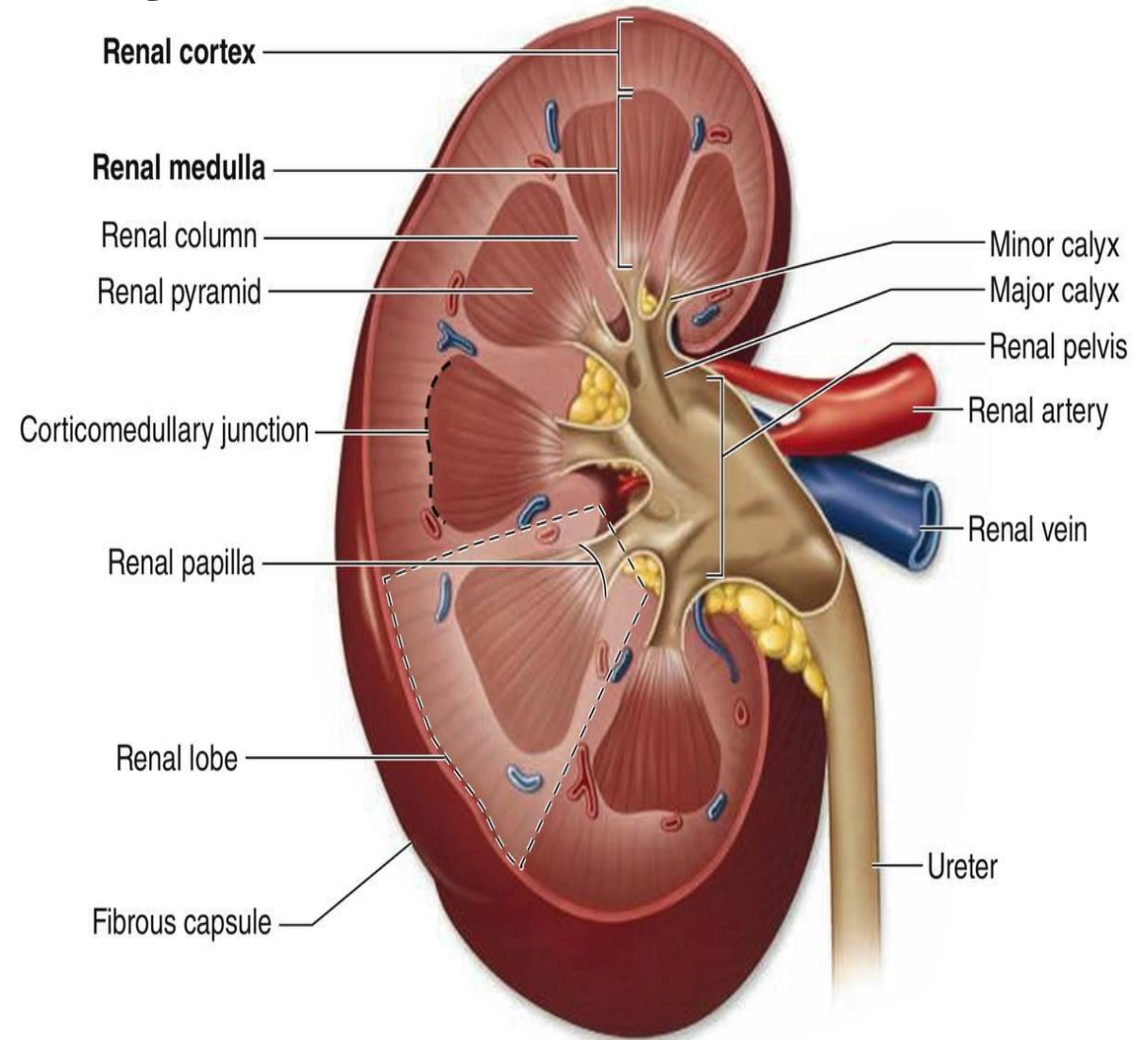
Gross Anatomy of Kidney (Contd.)

- Superior poles lies deep to the **lower ribs**
- Surrounded by protective **adipose tissue**
- Posterior heavy **musculature** provides further protection



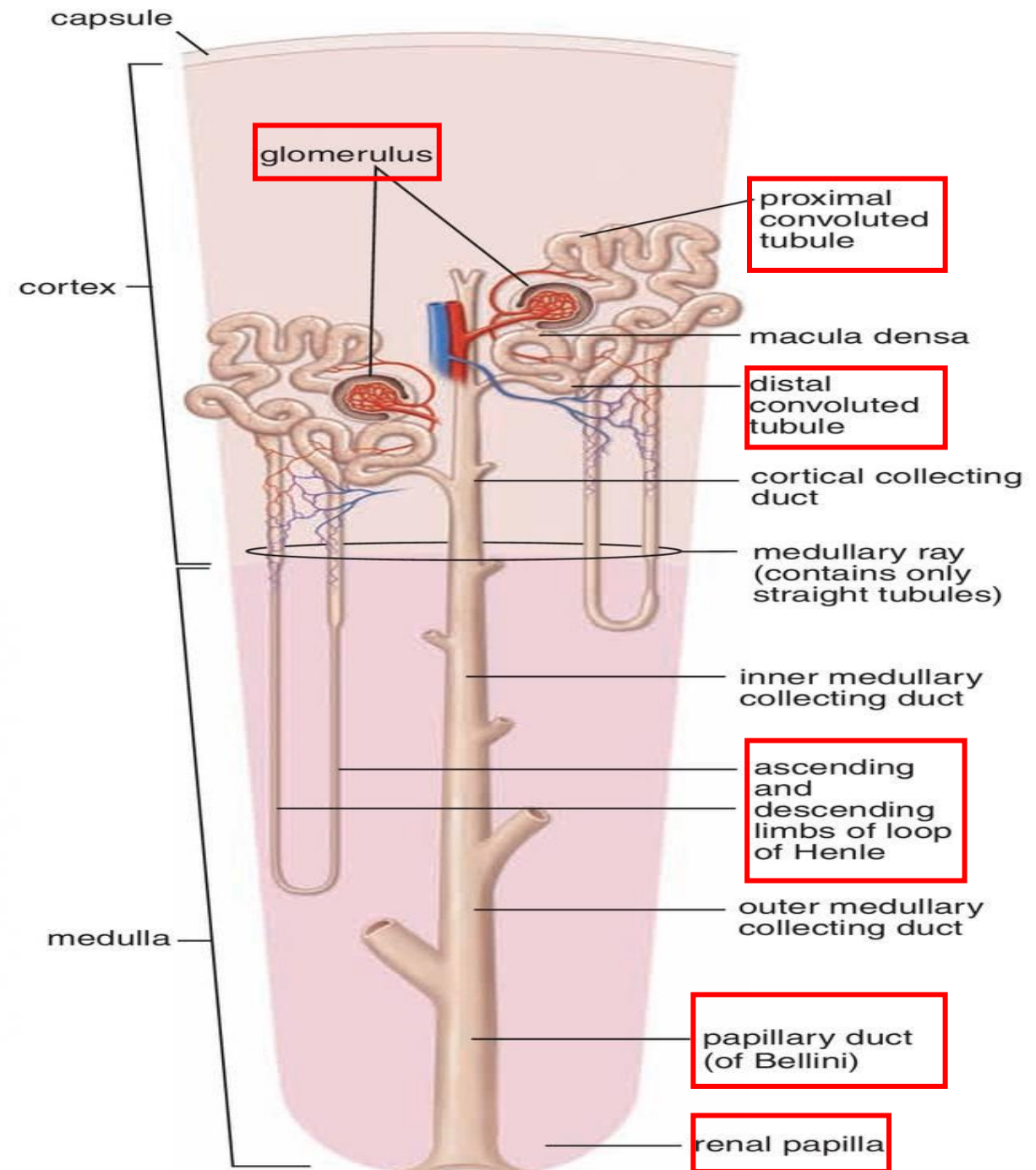
Macrostructures of Kidney

- **Renal Cortex:** Contains renal corpuscles and convoluted tubules
- **Renal Medulla:** Organized into several renal pyramids & renal columns in between
- **Renal Sinus:** Central potential space containing collecting system, vessels, nerves and fat



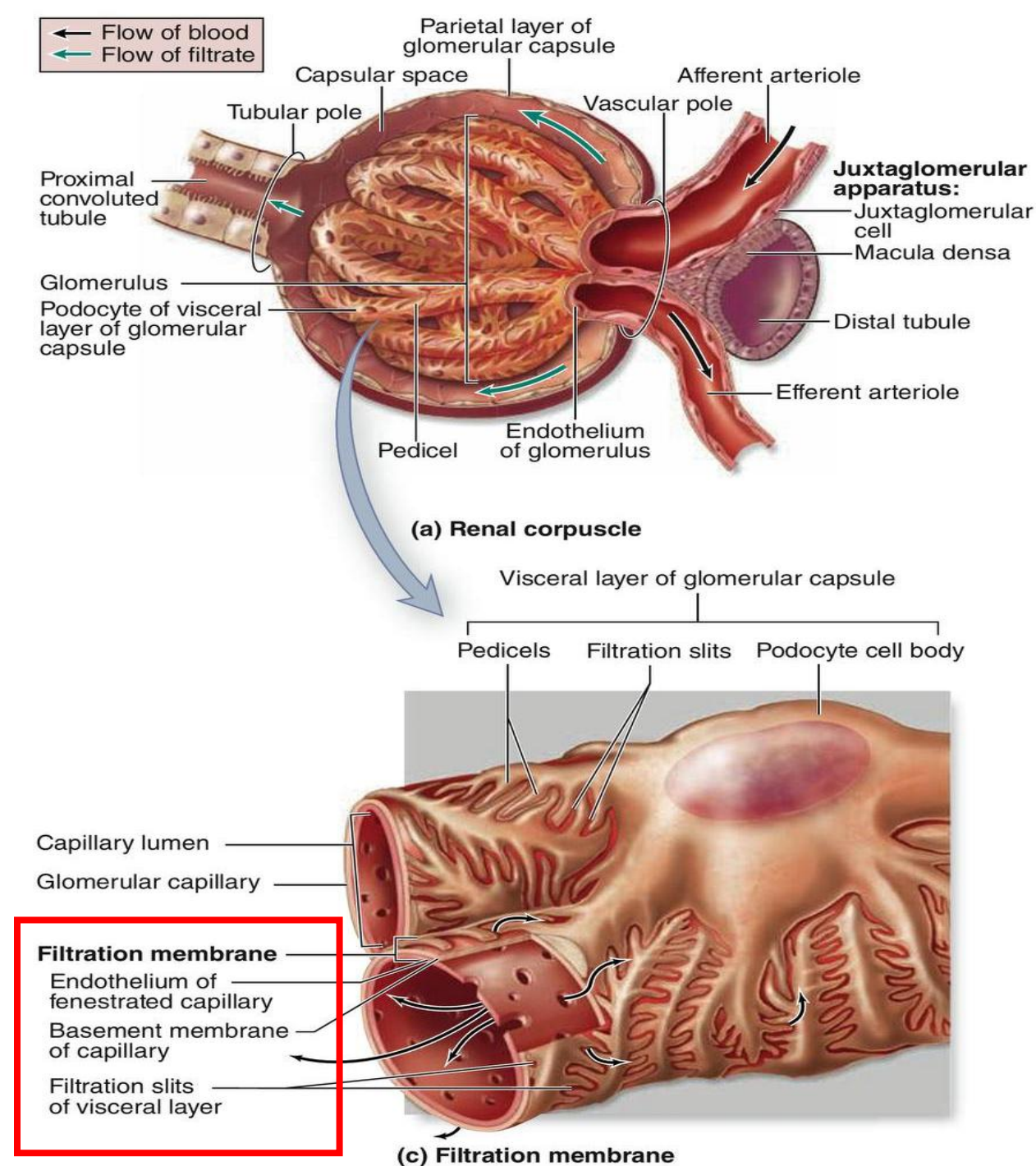
Microstructures

- **Nephron** - The structural and functional unit
- **Renal Corpuscle** – Forms Glomerulus & Bowman's capsule
- **PCT** - Reabsorption
- **Loop of Henle** - Consist of descending & ascending limb
- **DCT** - Regulation of electrolytes & pH of the urine
- **Collecting Tubules & Ducts**



Key Microstructures: Filtration Membrane

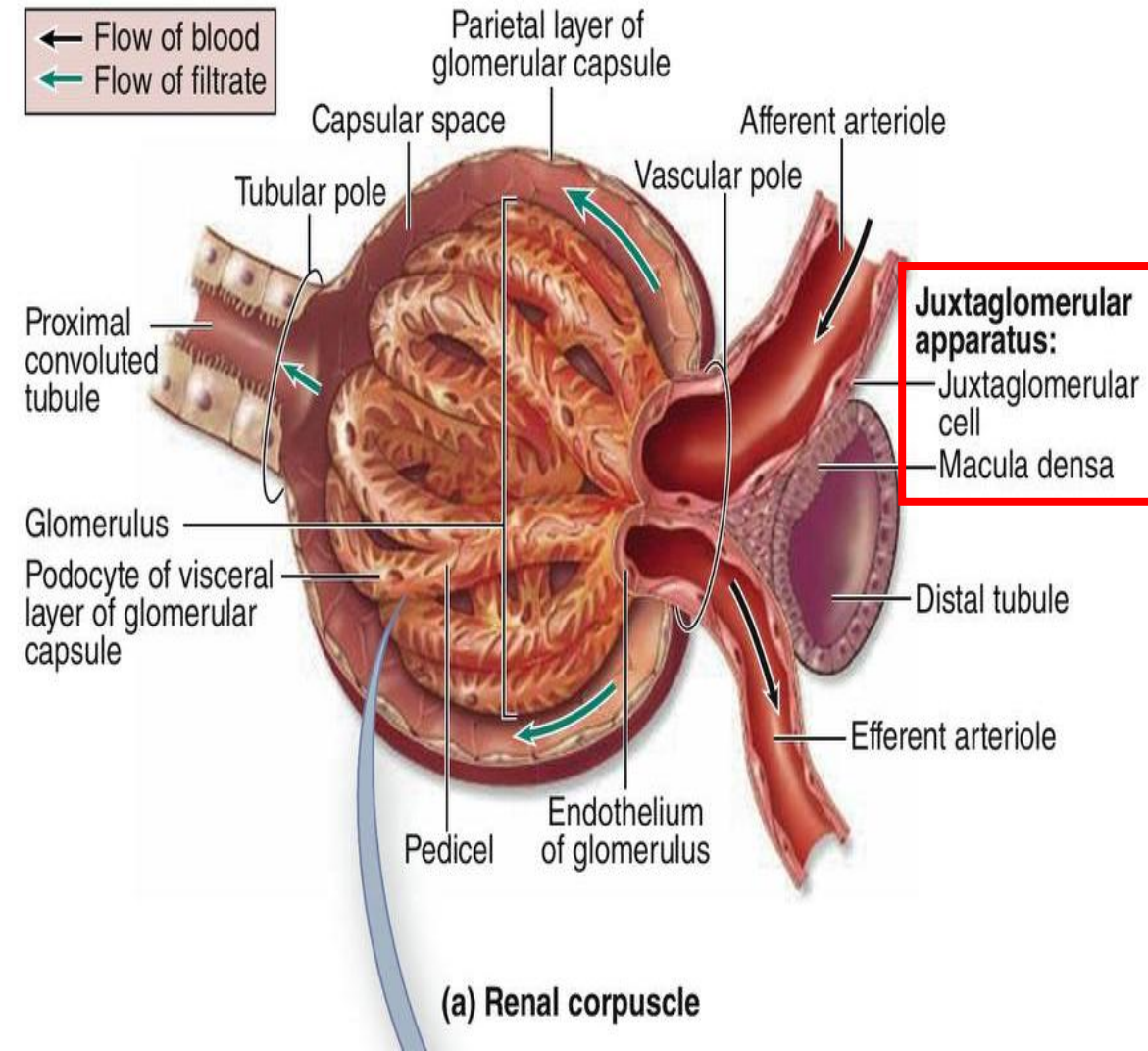
- Three layers of membrane
- Ultrafiltration of renal plasma occurs here
- Permit passage of water & small solutes
- Restricts cells and most plasma proteins



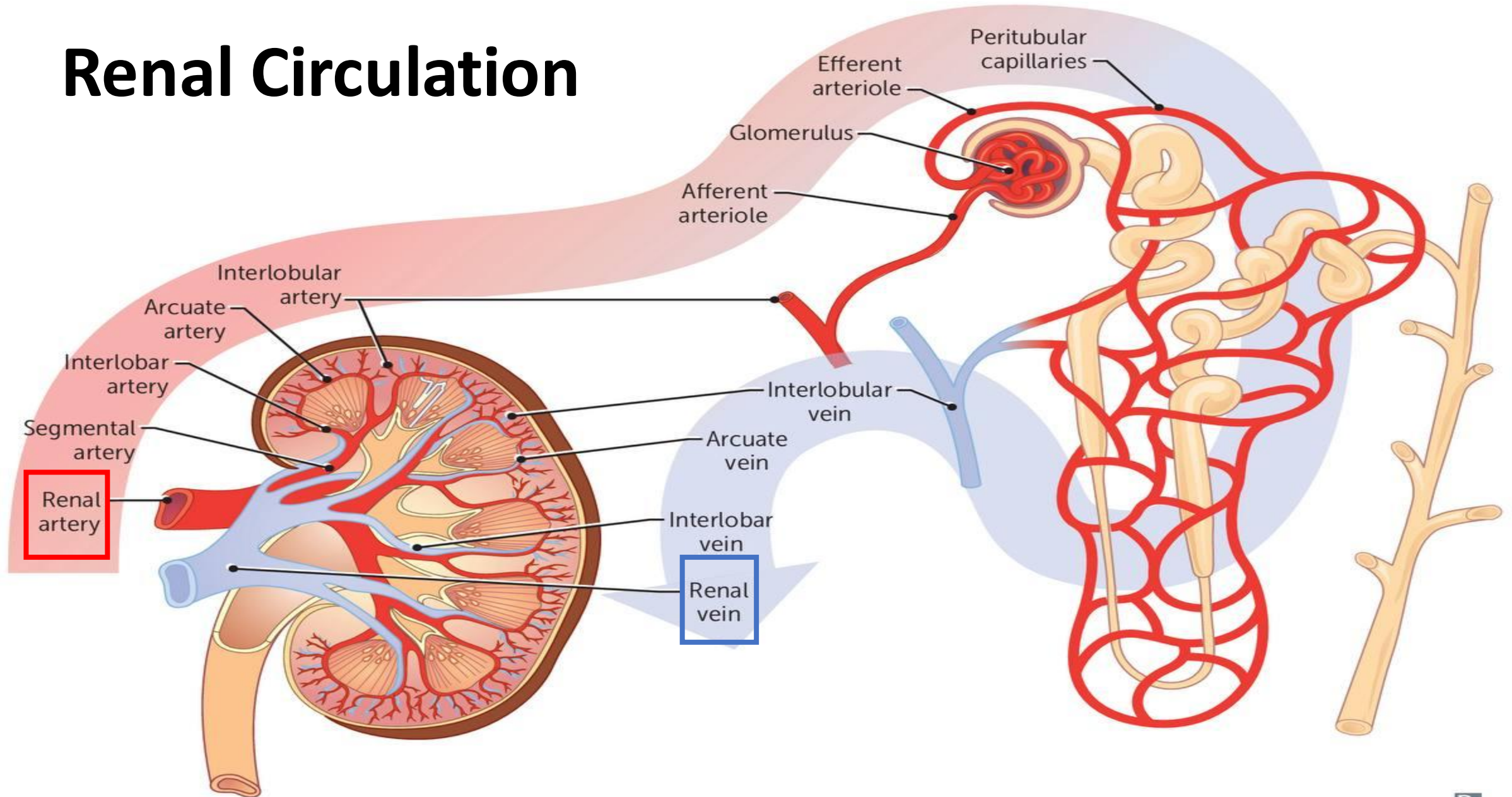
Key Microstructures: Juxtaglomerular Apparatus

- **JG cells** - Release Renin
- **Macula Densa** - Senses NaCl
- **Lacis cells** - Signaling/support

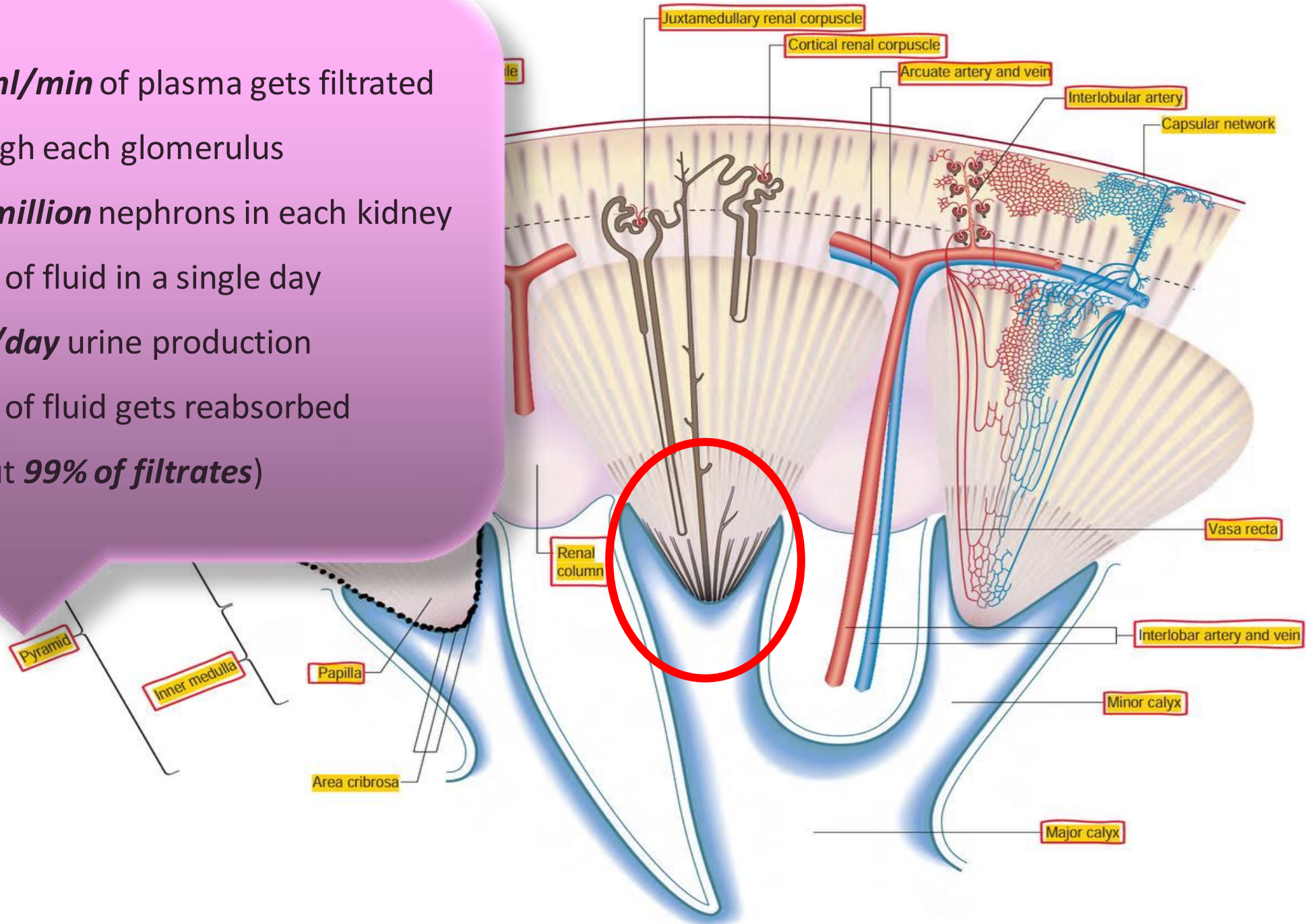
Regulates GFR, Renal perfusion
and Systemic BP



Renal Circulation



- ❑ **125 ml/min** of plasma gets filtrated through each glomerulus
- ❑ **One million** nephrons in each kidney
- ❑ **180 L** of fluid in a single day
- ❑ **1-2 L/day** urine production
- ❑ **178 L** of fluid gets reabsorbed (about **99% of filtrates**)



Beyond Anatomy
Renal Function & Clinical Relevance

The Kidney: More than an Excretory Organ



Excretory

Removes what the body doesn't need

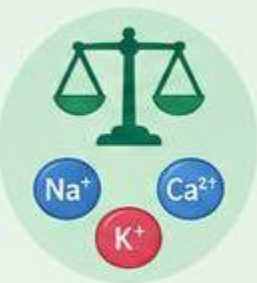
- Eliminates metabolic waste products (urea, creatinine, uric acid)
- Removes drugs and foreign substances



Homeostatic

Keeps the internal environment stable

- Regulates water & electrolyte balance (Na^+ , K^+ , Ca^{2+} , Mg^{2+})
- Maintains acid–base balance (H^+ excretion)
- Regulates arterial blood pressure (RAAS, volume control)



Endocrine

Signals for whole-body regulation

EPO

→ Erythropoietin
(RBC production)

Renin

→ Renin
(RAAS activation → BP regulation)

Calcitriol

→ Calcitriol
(Ca^{2+} / PO_4^{3-} homeostasis)

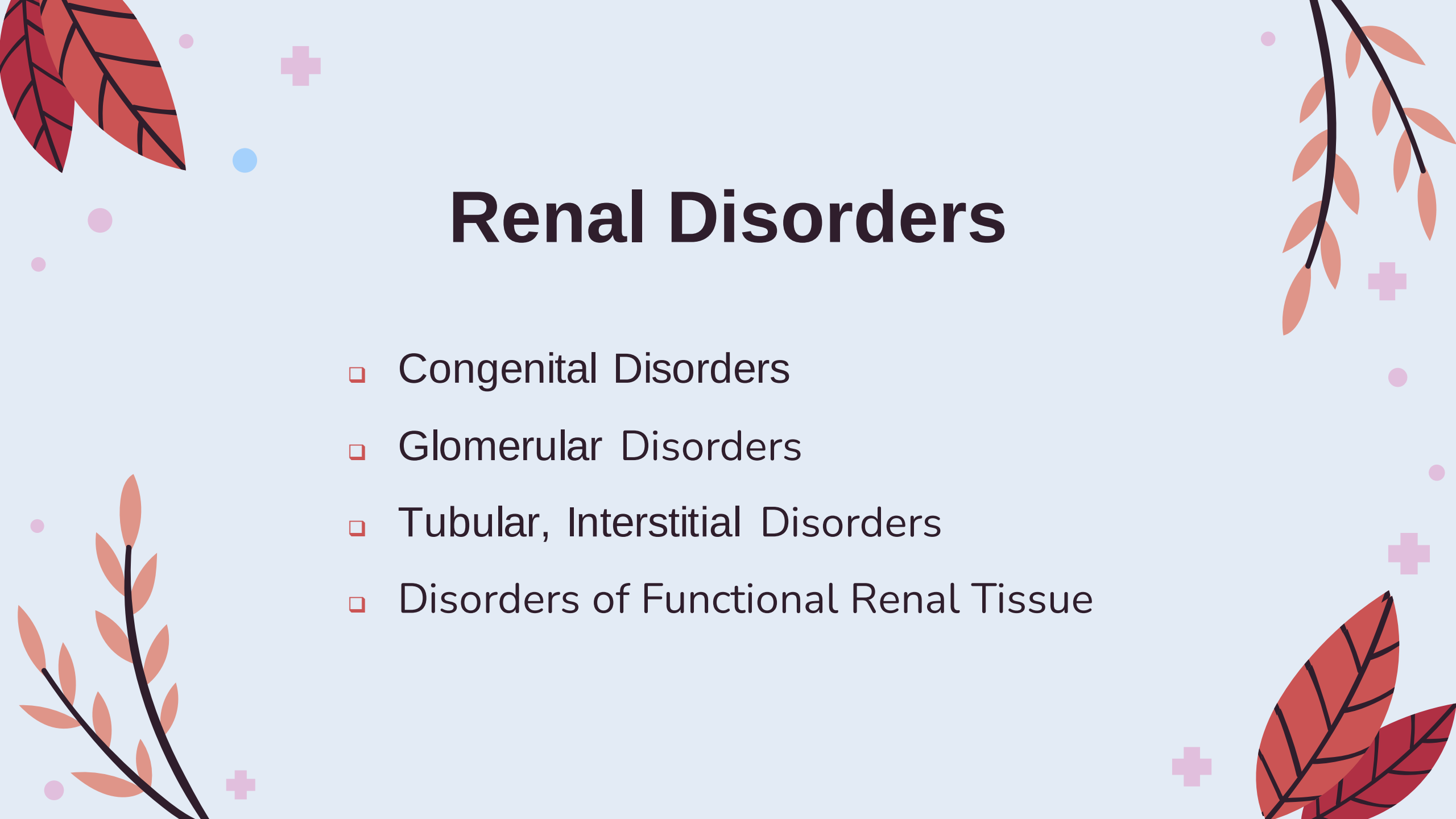


Metabolic

Supports energy balance

- Gluconeogenesis (during prolonged fasting)

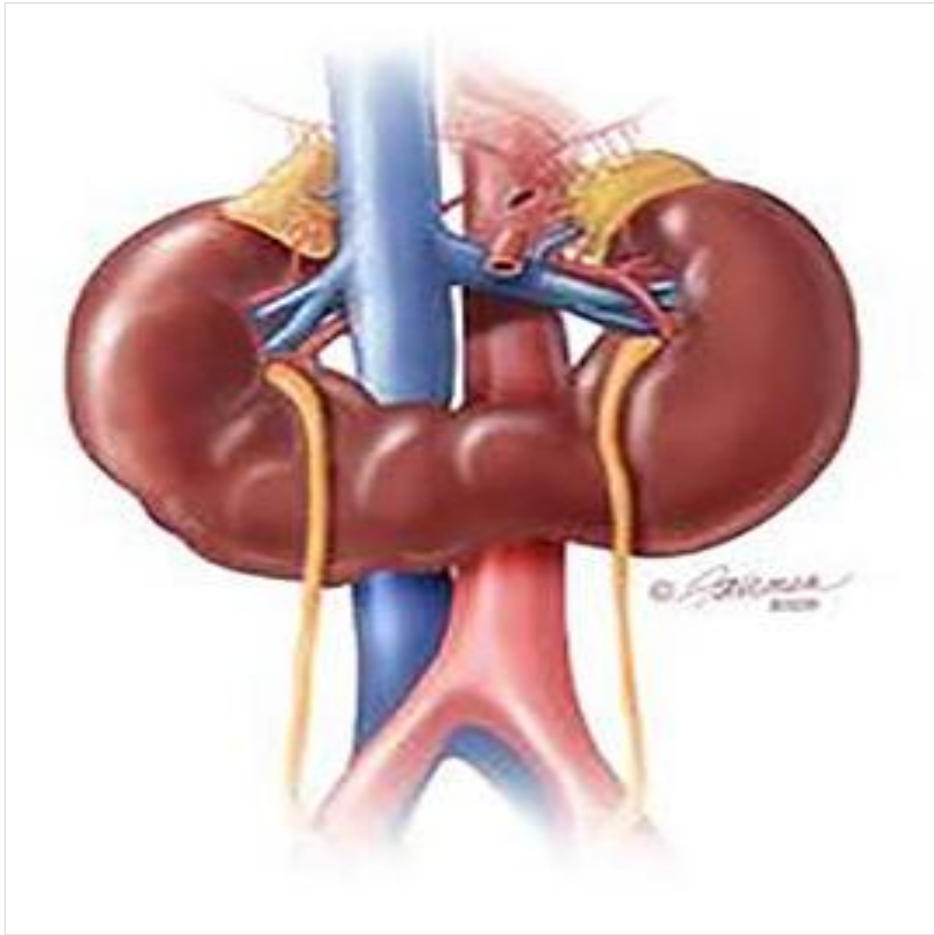




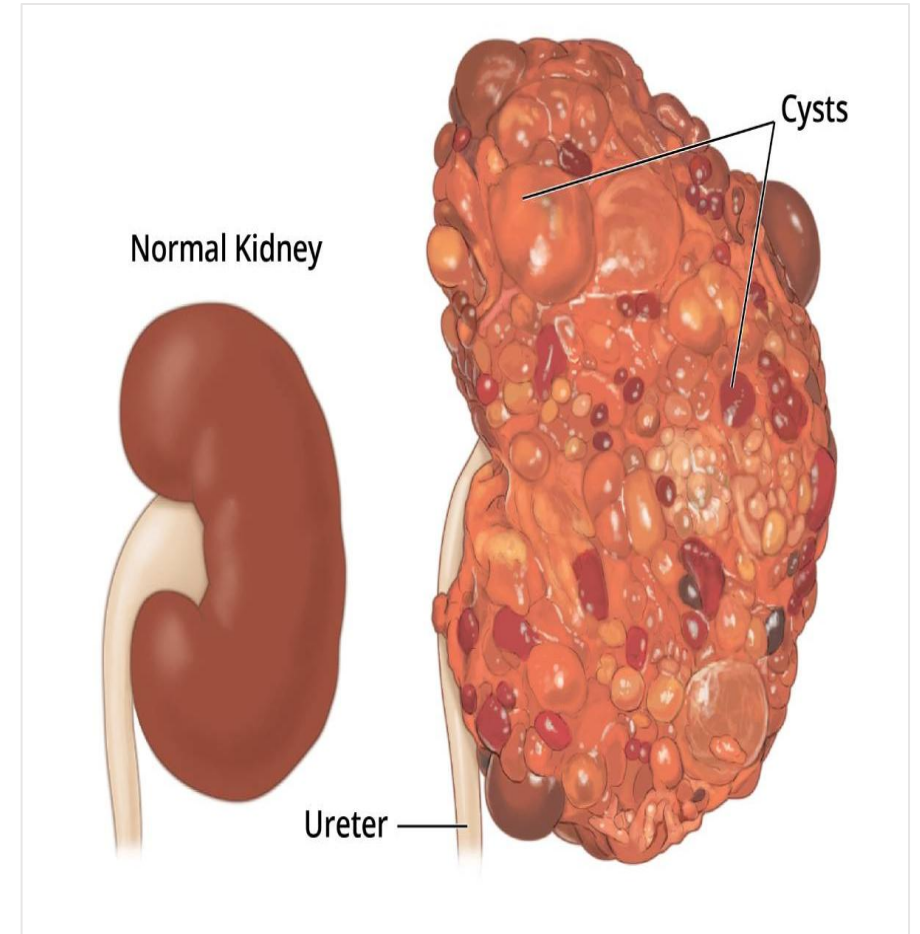
Renal Disorders

- ❑ Congenital Disorders
- ❑ Glomerular Disorders
- ❑ Tubular, Interstitial Disorders
- ❑ Disorders of Functional Renal Tissue

1. Congenital Disorders

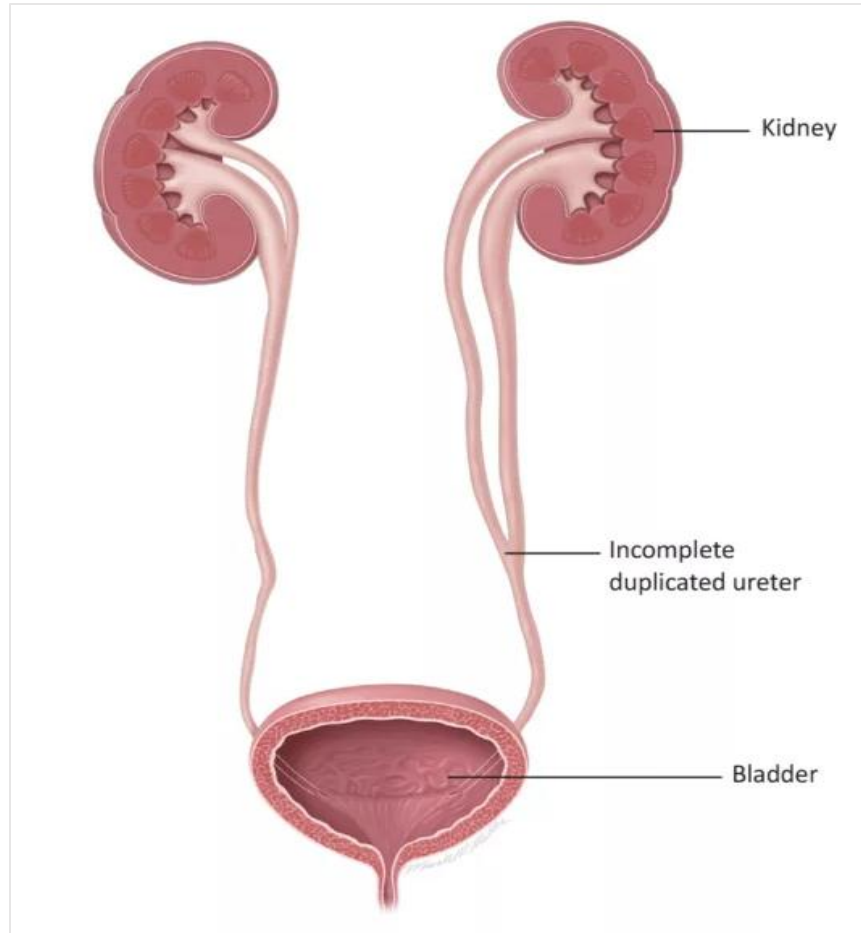


Horseshoe Kidney

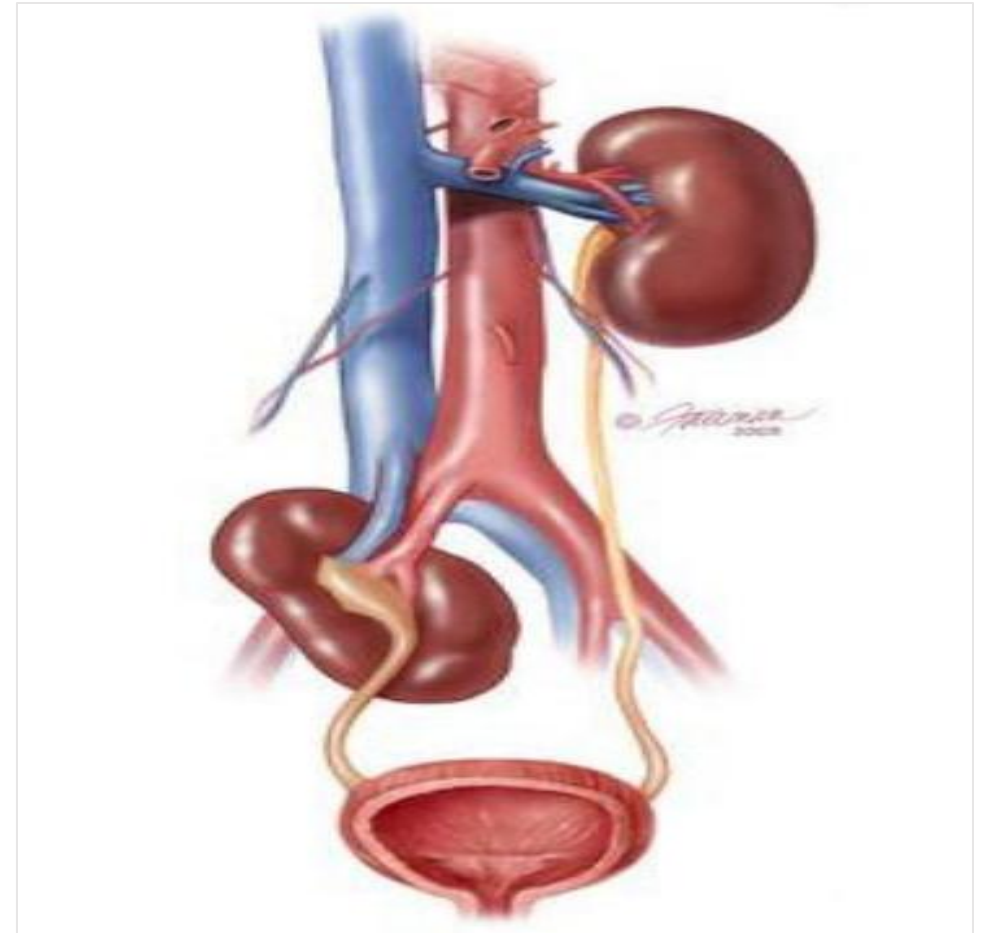


Polycystic Kidney Disease

1. Congenital Disorders (Contd.)



Duplicated Collecting System



Ectopic Kidney

2. Glomerular Disorders

- **Nephrotic syndrome:** Glomerular injury causing heavy proteinuria
- **Nephritic syndrome:** Glomerular inflammation with hematuria and reduced GFR
- **Diabetic nephropathy:** Glomerular damage associated with chronic DM
- **Autoimmune glomerular disorders:** Immune-mediated glomerular injury
 - IgA nephropathy
 - Goodpasture syndrome
 - Renal amyloidosis
 - SLE (Systemic Lupus Erythematosus)

3. Tubular, Interstitial Disorders (i.e. AKI)

1

Pre-renal

↓ Renal blood flow → ↓ GFR

Problem lies in the circulation
(to the kidney), not the kidney itself.



Renal artery

↓ Renal perfusion



↓ Glomerular pressure



↓ GFR

Common causes

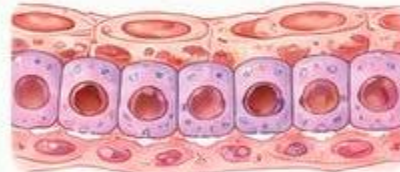
- Hypovolemia (dehydration, bleeding)
- Shock / sepsis
- Heart failure
- Renal artery stenosis

2

Intrinsic

Damage to renal parenchyma

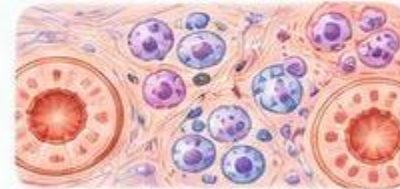
Tubular injury (ATN)



Tubular epithelial cell injury
(ischemic/toxic)

- Acute tubular necrosis (ATN)
- Drugs, contrast, ischemia

Interstitial injury (AIN)



Inflammation in the interstitium

- Acute interstitial nephritis (AIN)
- Drugs, infection, autoimmune

Vascular / Glomerular injury



- Glomerulonephritis
- Thrombotic microangiopathy
- Vascular injury

3

Post-renal

Obstruction → ↑ Back pressure → ↓ GFR



Renal pelvis

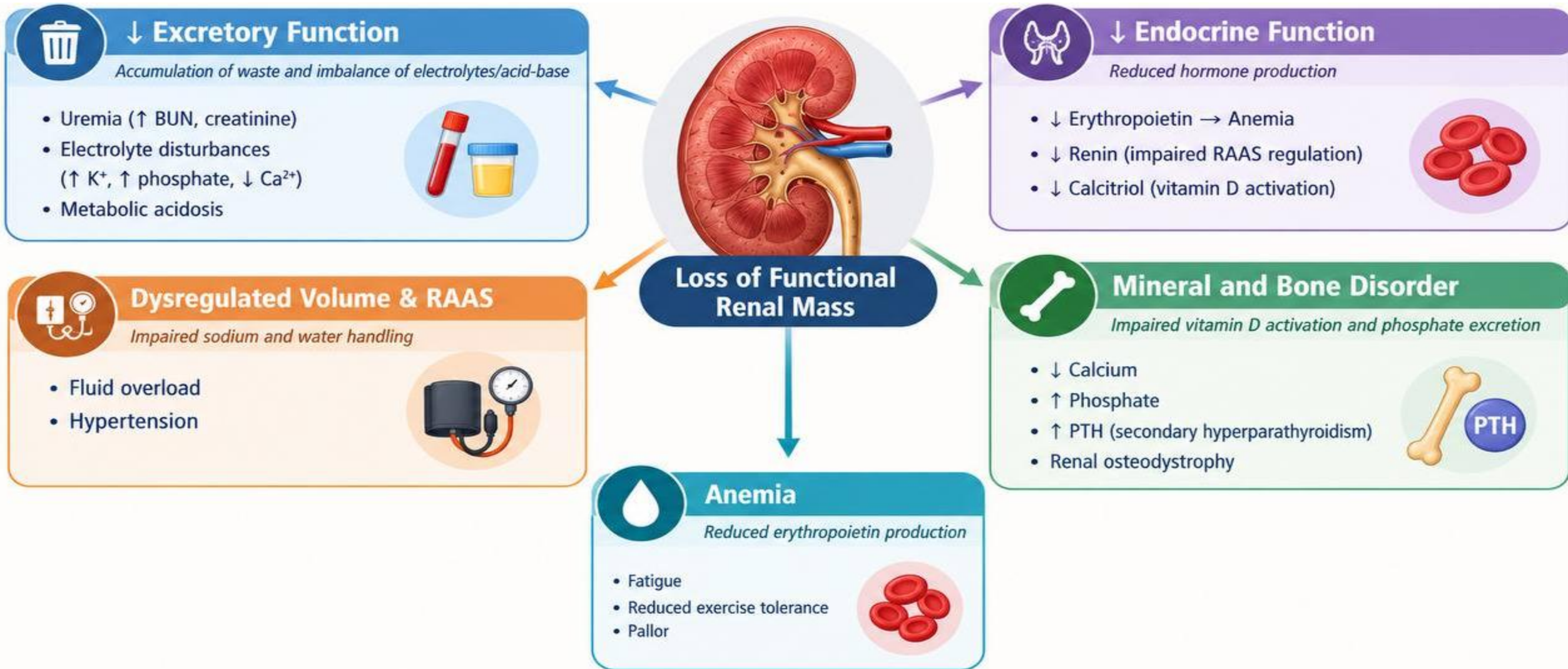
Obstruction
(e.g. stone, stricture, tumor)

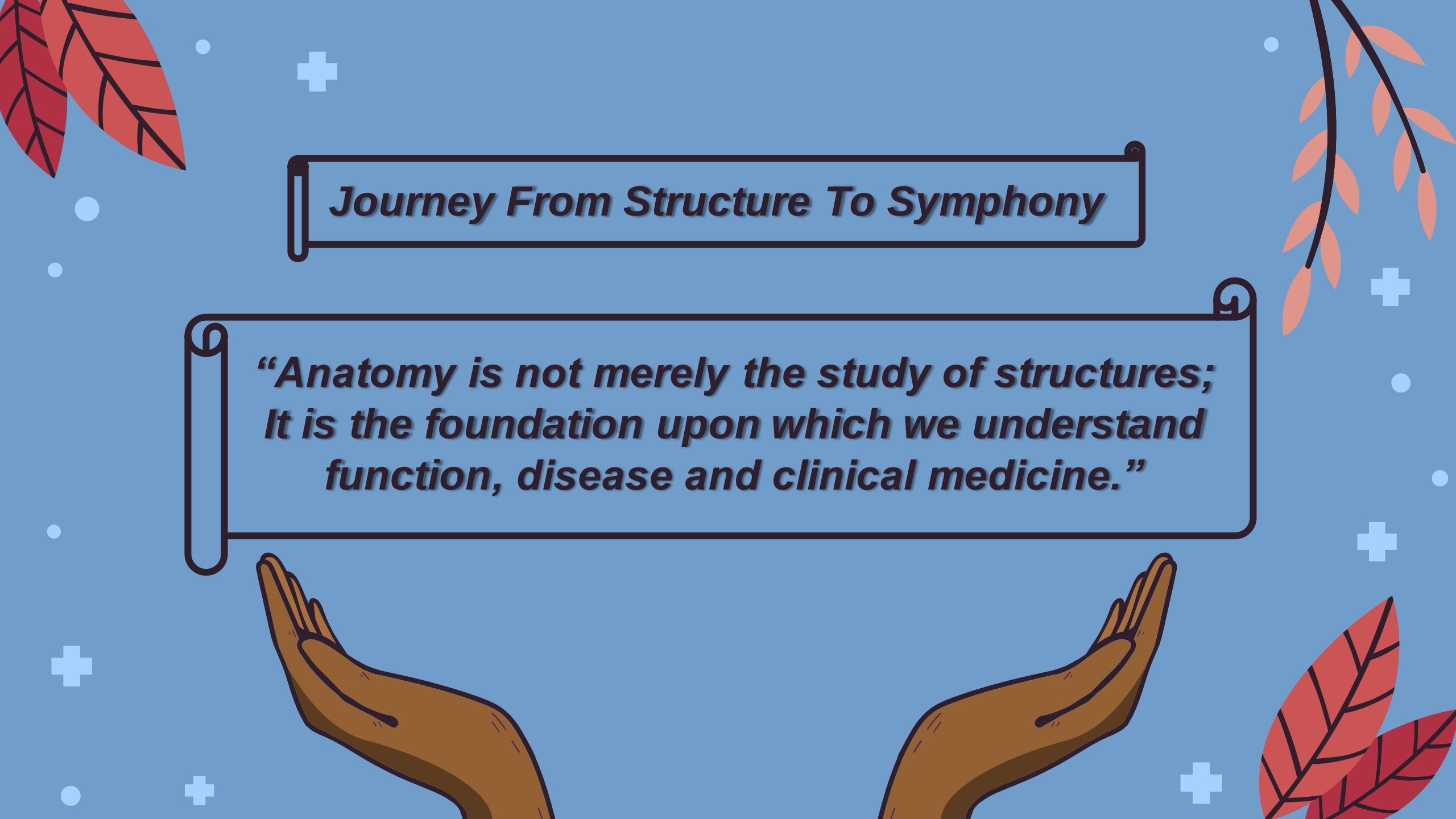
Ureter

Common causes

- Ureteric stone
- Benign prostatic hyperplasia
- Tumor
- Stricture
- Neurogenic bladder

4. Disorder of Functional Renal Tissue - CKD

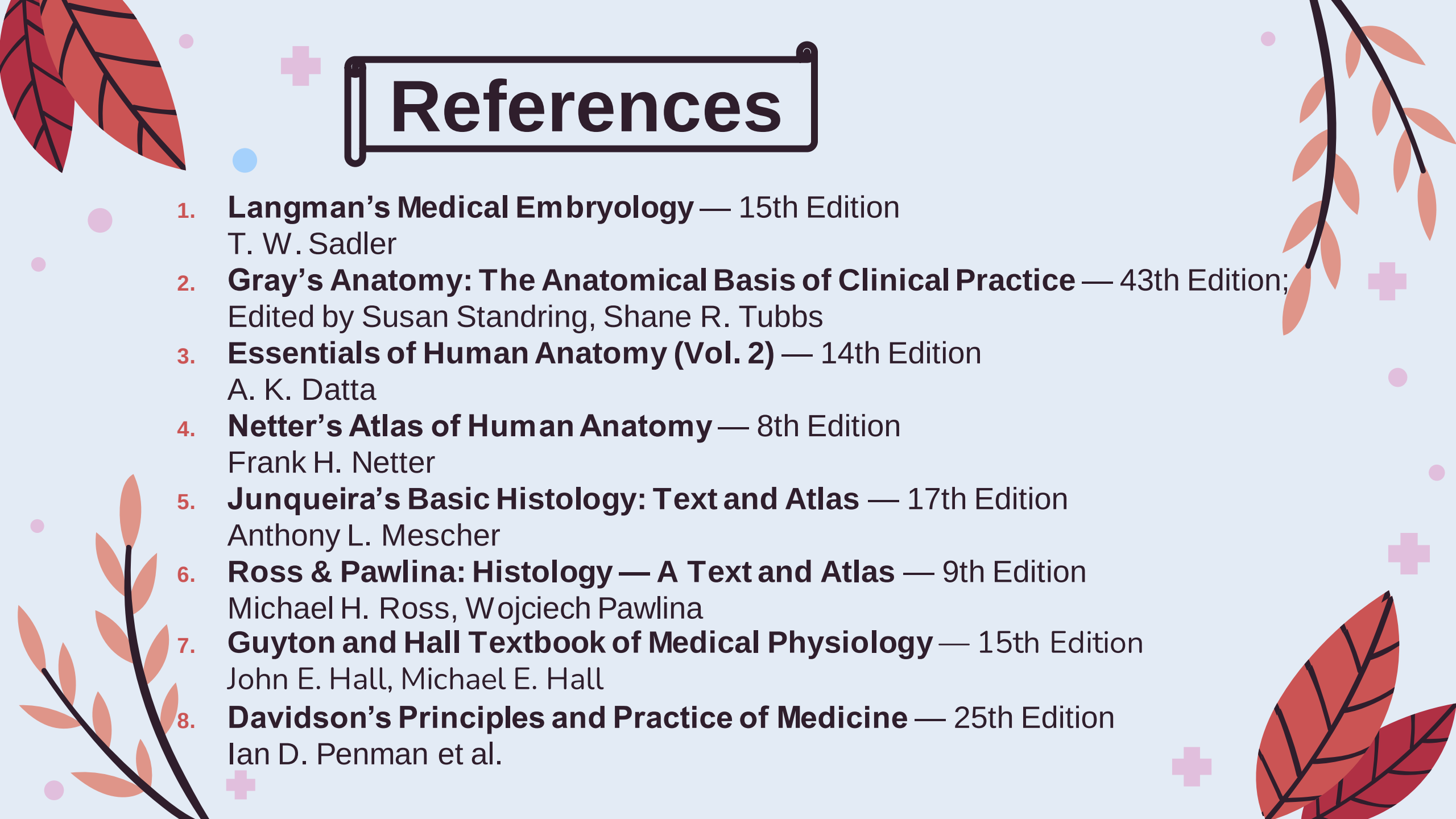




Journey From Structure To Symphony

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"STAY HYDRATED"

**Thank
You**

