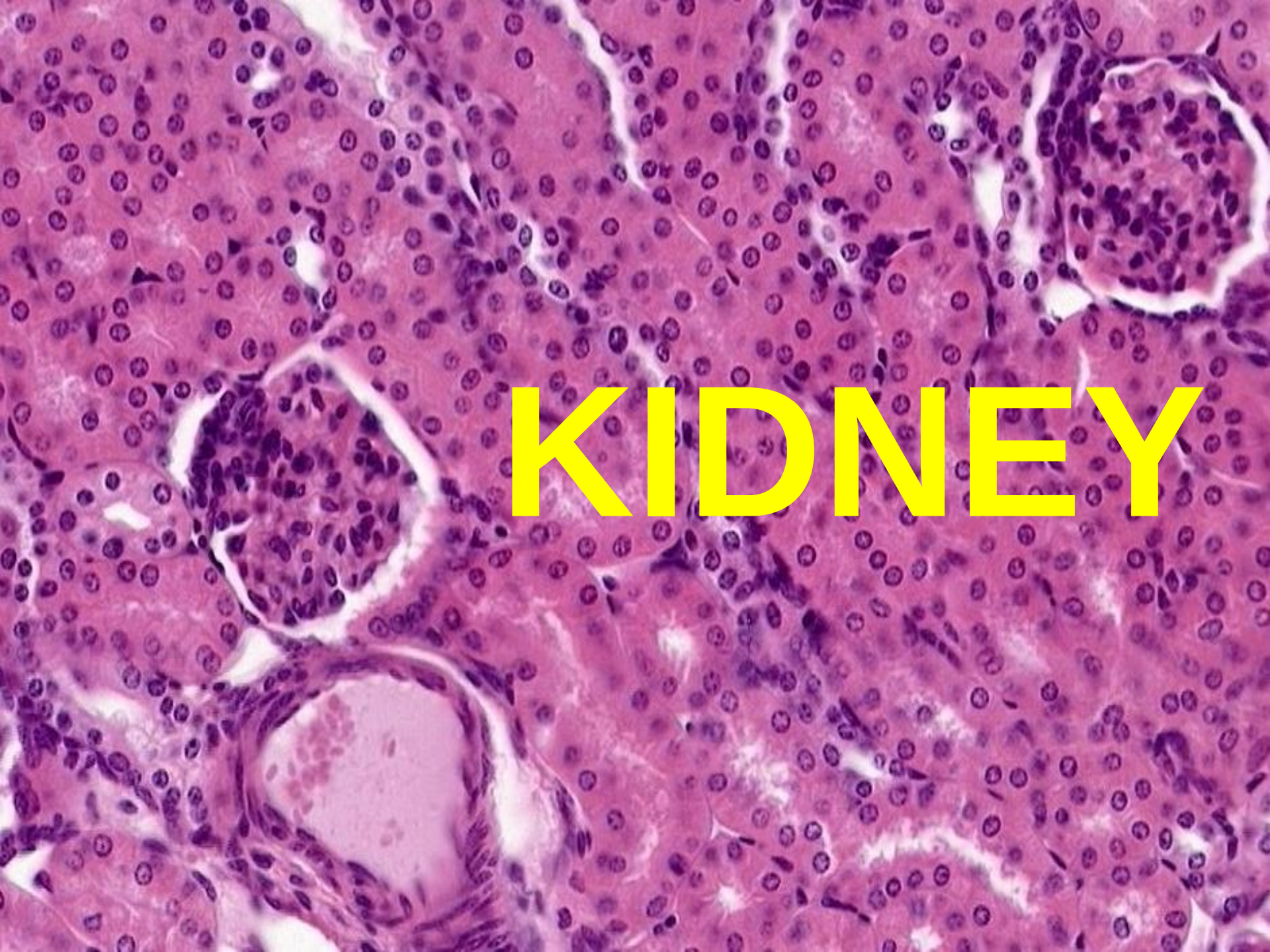
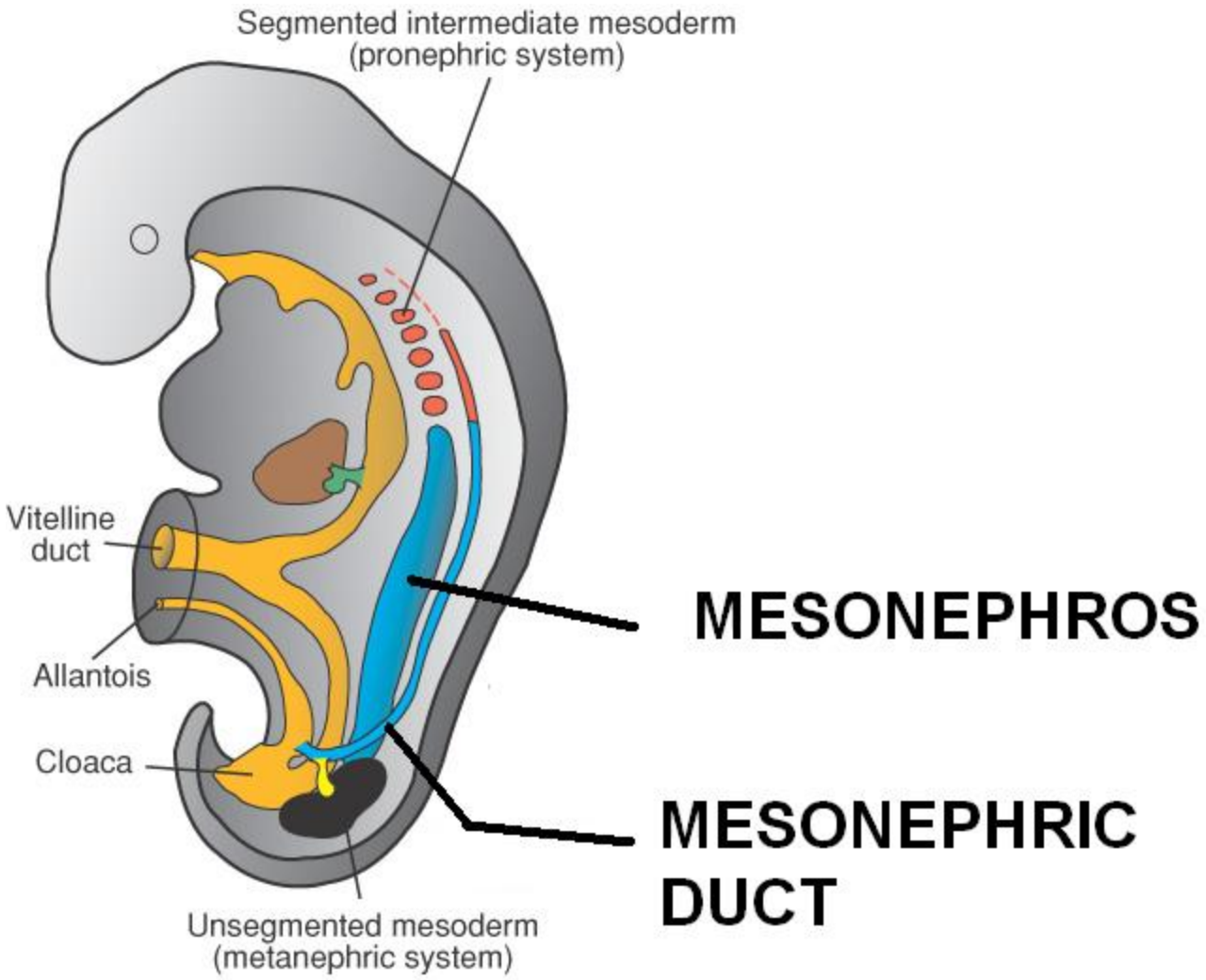
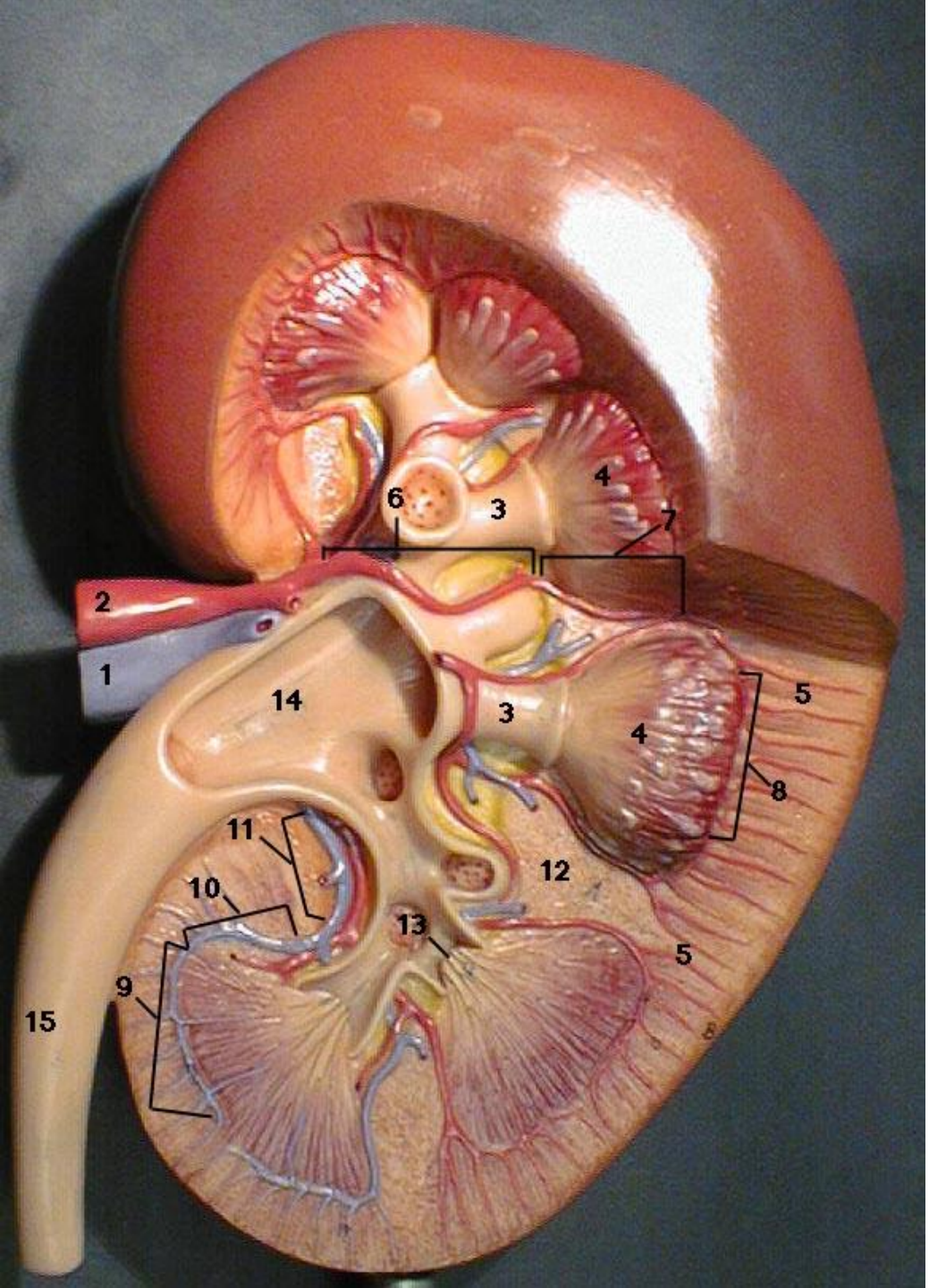

KIDNEY

# RENAL PATHOLOGY

- NORMAL
- CONGENITAL
- “CYSTS”
- GLOMERULAR
- TUBULAR/INTERSTITIAL
- BLOOD VESSELS
- OBSTRUCTION
- TUMORS


Segmented intermediate mesoderm
(pronephric system)
Vitelline
duct
Allantois
Cloaca
Unsegmented mesoderm
(metanephric system)
MESONEPHROS
MESONEPHRIC
DUCT


6
3
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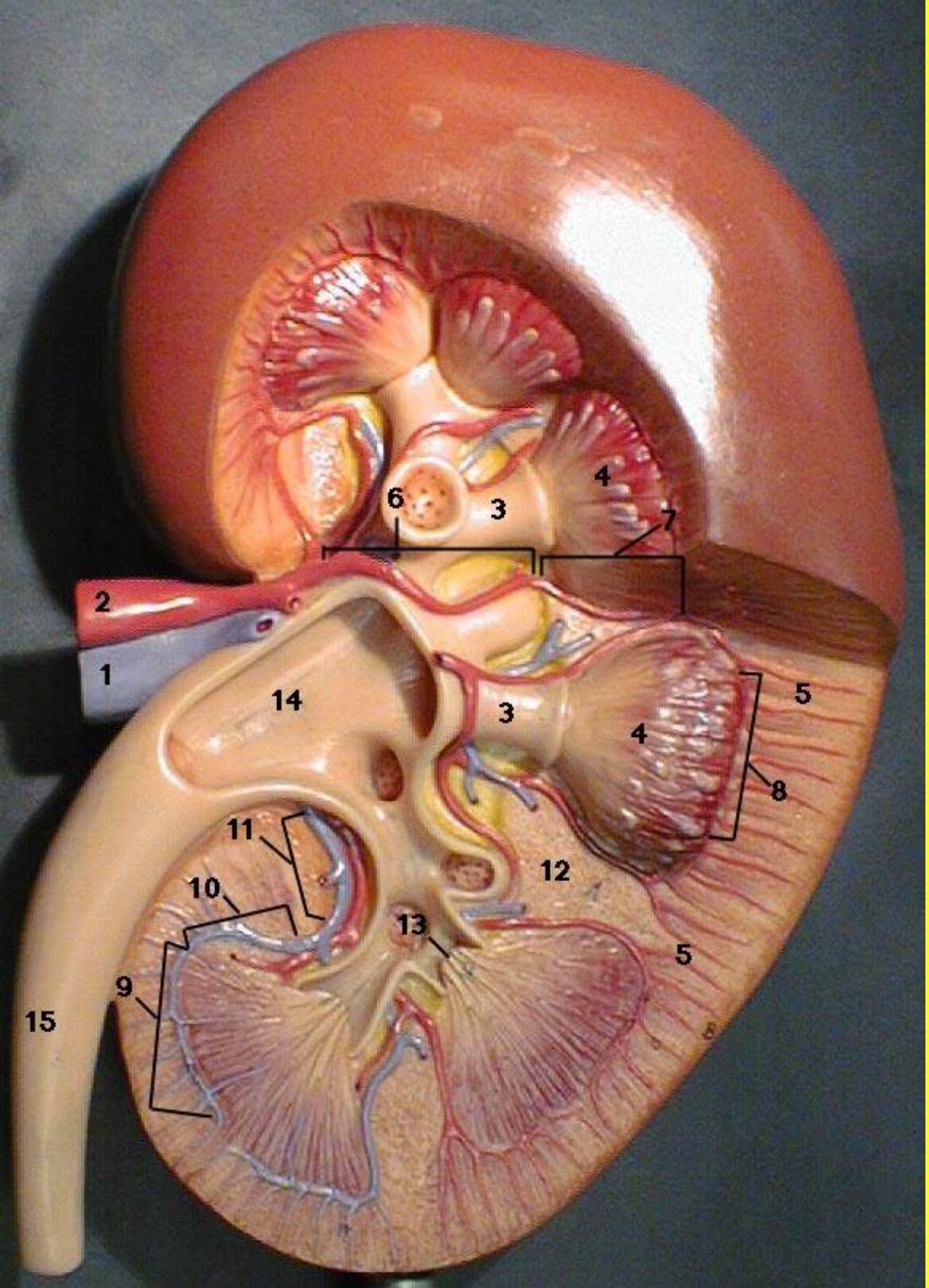
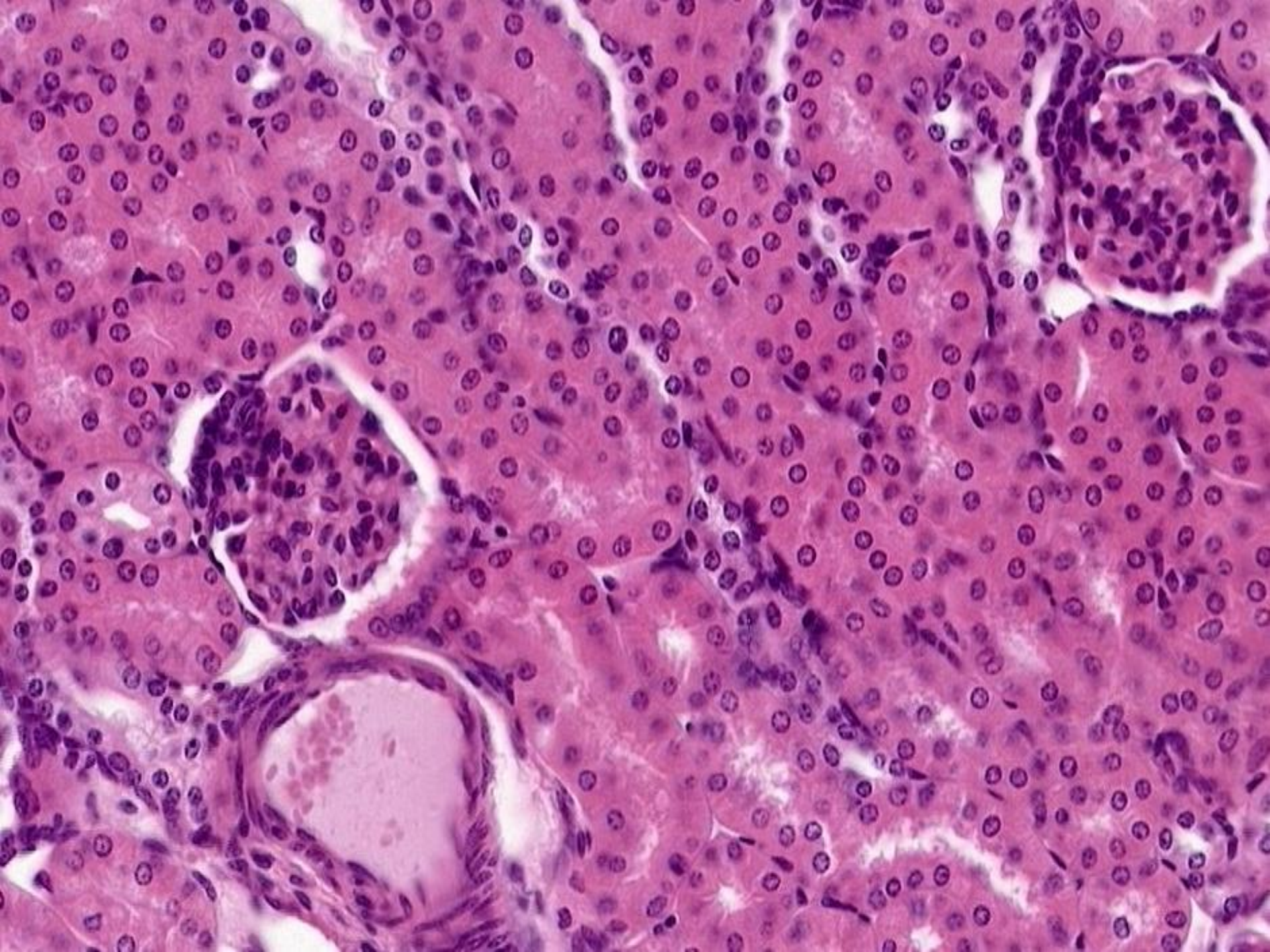
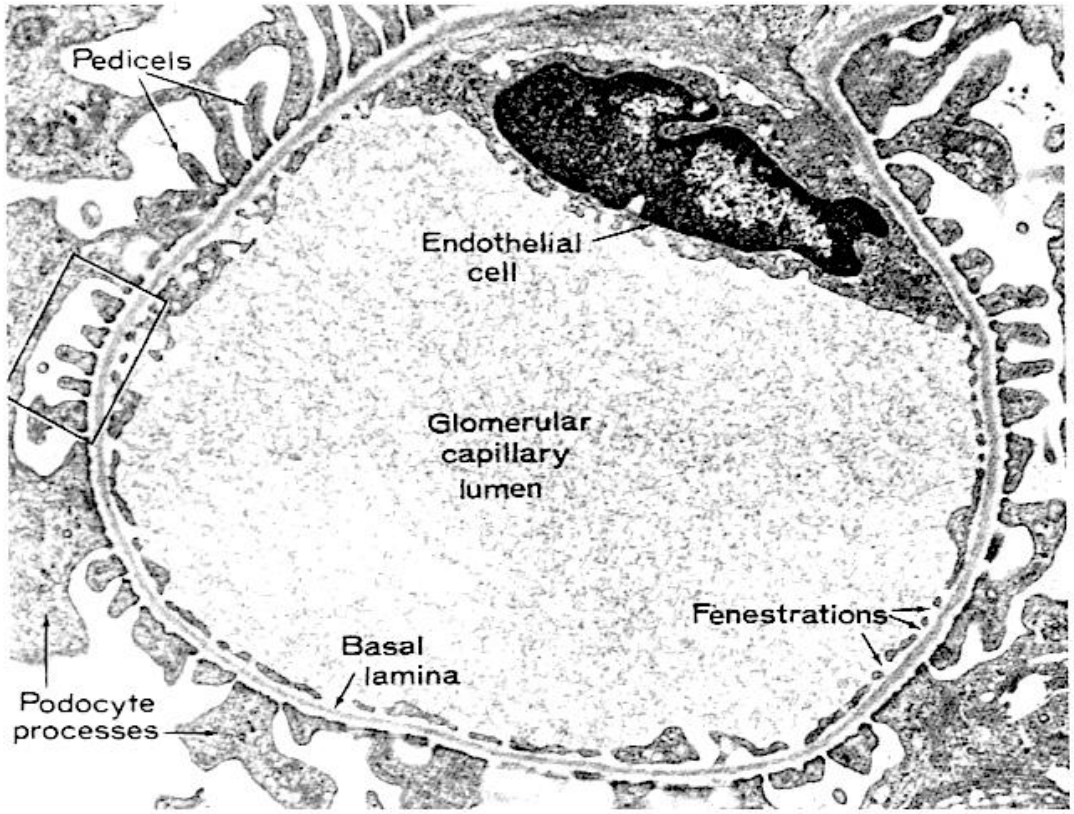
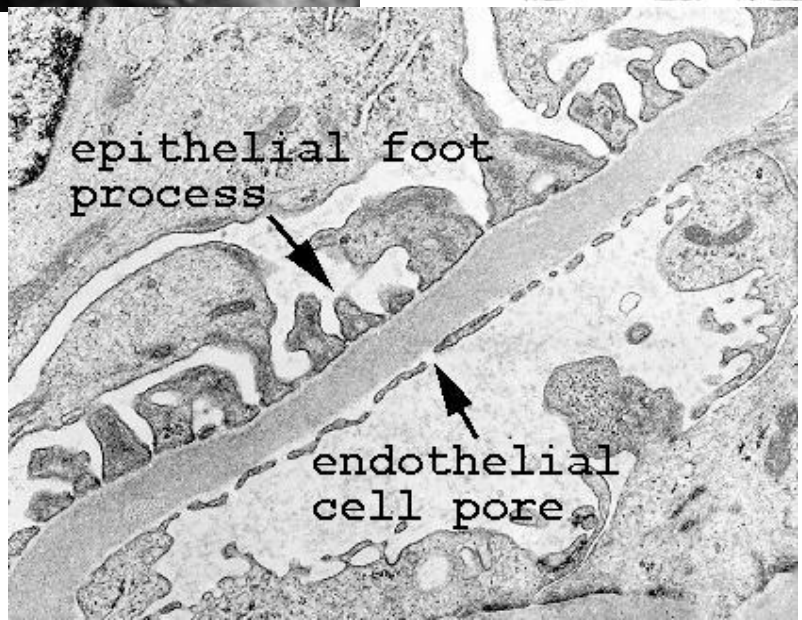



1. Renal Vein
2. Renal Artery
3. Renal Calyx
4. Medullary Pyramid
5. Renal Cortex
6. Segmental Artery
7. InterlobAR Artery
8. Arcuate Artery→ interlobULAR
9. Arcuate Vein
10. Interlobar Vein
11. Segmental Vein
12. Renal Column
13. Renal Papillae
14. Renal Pelvis
15. Ureter

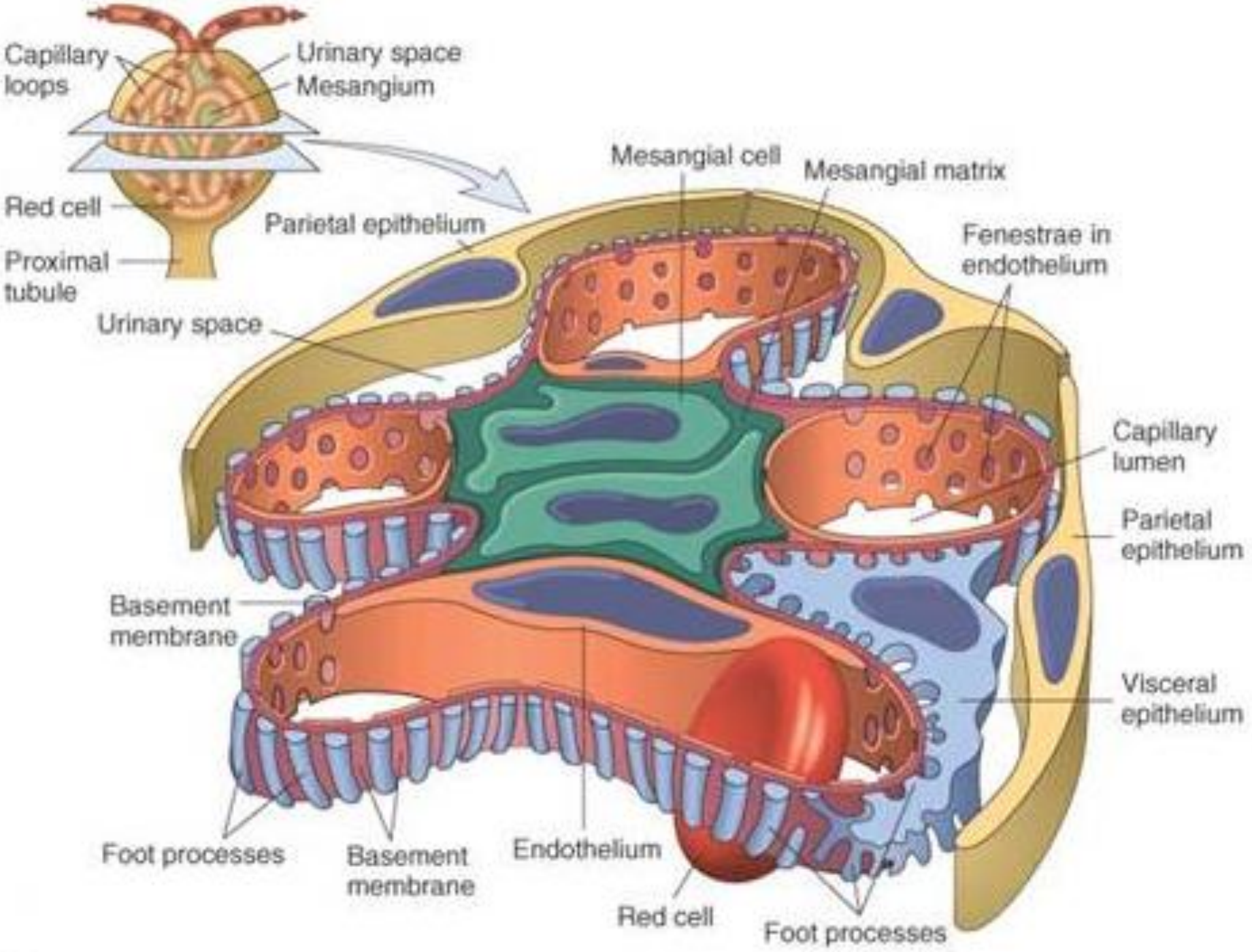



Pedicels
Endothelial cell
Glomerular capillary lumen
Fenestrations
Basal lamina
Podocyte processes

S.E.M.


epithelial foot process
endothelial cell pore

T.E.M.


Capillary loops
Urinary space
Mesangium
Red cell
Proximal tubule
Parietal epithelium
Mesangial cell
Mesangial matrix
Fenestrae in endothelium
Urinary space
Capillary lumen
Parietal epithelium
Basement membrane
Visceral epithelium
Foot processes
Basement membrane
Endothelium
Red cell
Foot processes

# CHRONIC RENAL FAILURE

***Fluid and Electrolytes:*** **Dehydration, Edema, Hyperkalemia, Metabolic acidosis**

***Calcium Phosphate and Bone:*** **Hyperphosphatemia, Hypocalcemia, Secondary hyperparathyroidism, Renal osteodystrophy**

***Hematologic:*** **Anemia, Bleeding diathesis**

***Cardiopulmonary:*** **Hypertension, Congestive heart failure, Pulmonary edema, Uremic pericarditis**

***Gastrointestinal:*** **Nausea and vomiting, Bleeding, Esophagitis, gastritis, colitis**

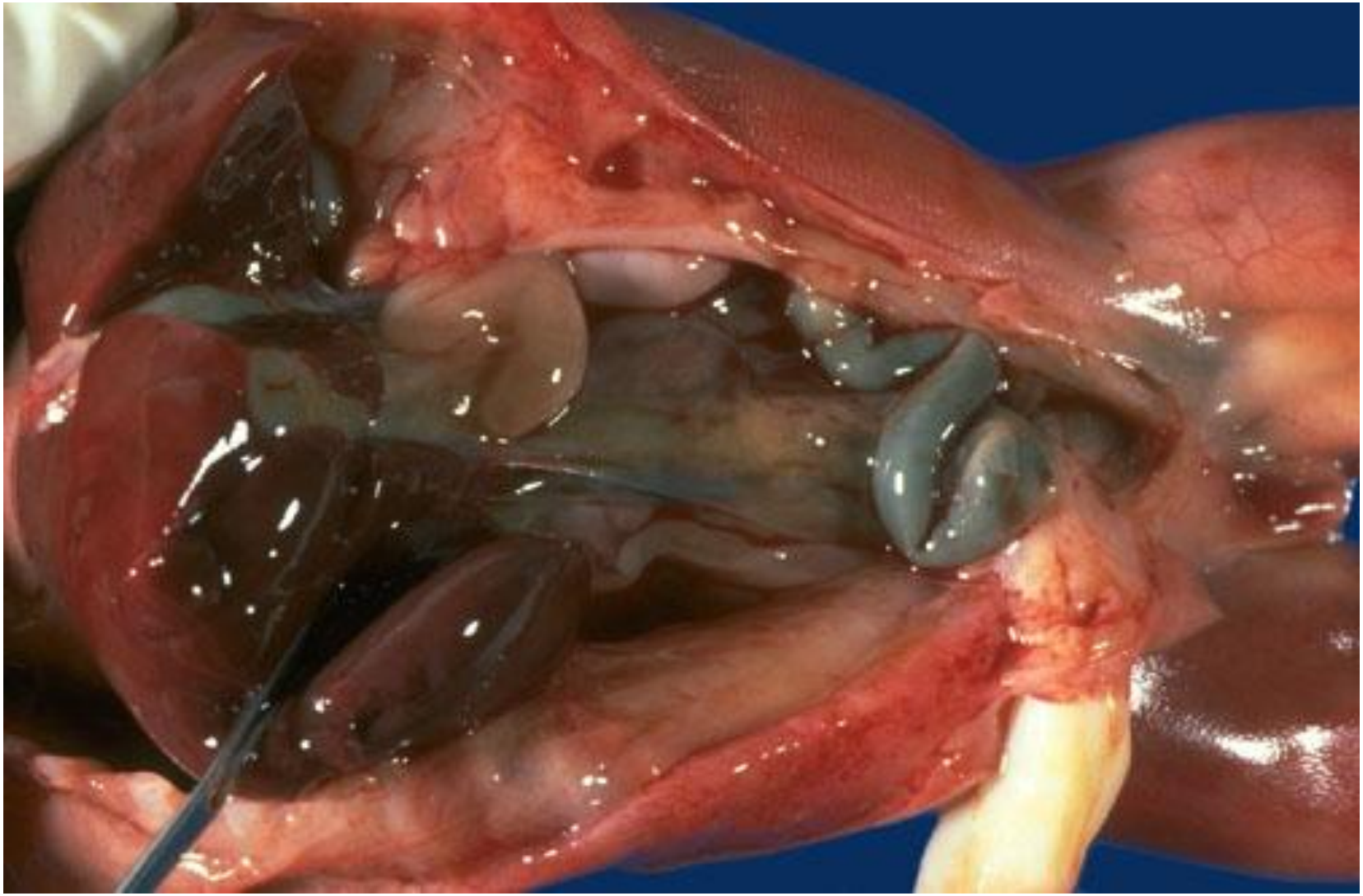
***Neuromuscular:*** **Myopathy, Peripheral neuropathy, Encephalopathy**

***Dermatologic:*** **Sallow (greenish-yellow) color, Pruritus, Dermatitis**

# CONGENITAL

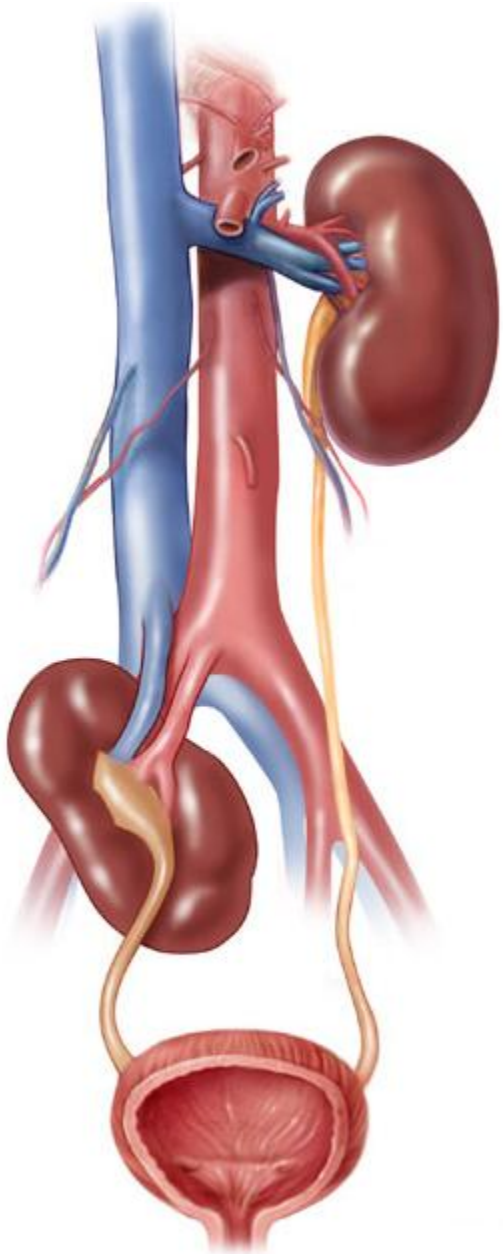
- AGENESIS
- HYPOPLASIA
- ECTOPIC
- HORSESHOE

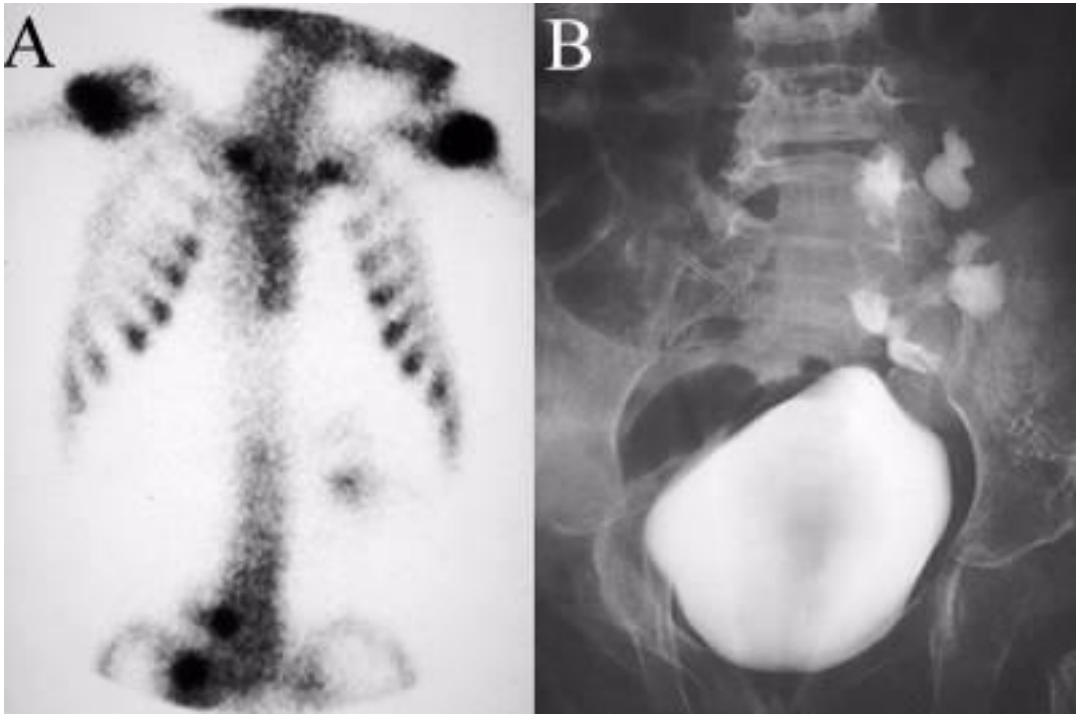
# AGENESIS



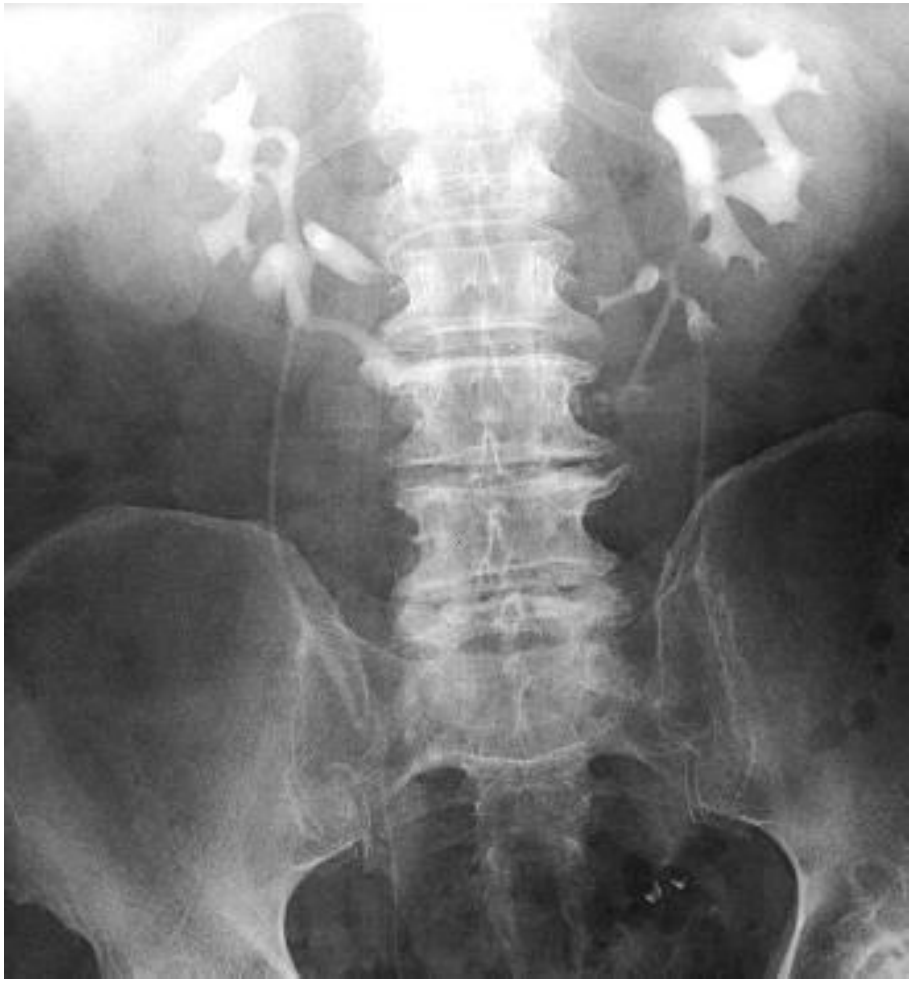
# HYPOPLASIA

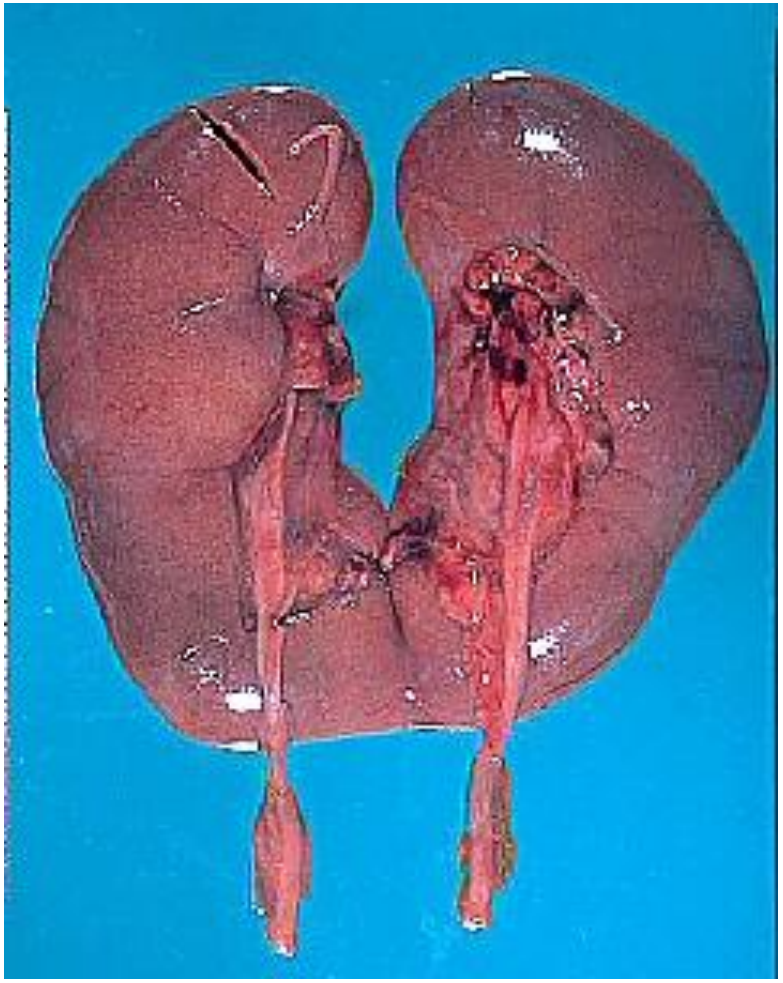
# ECTOPIC (usually PELVIC)





# HORSESHOE



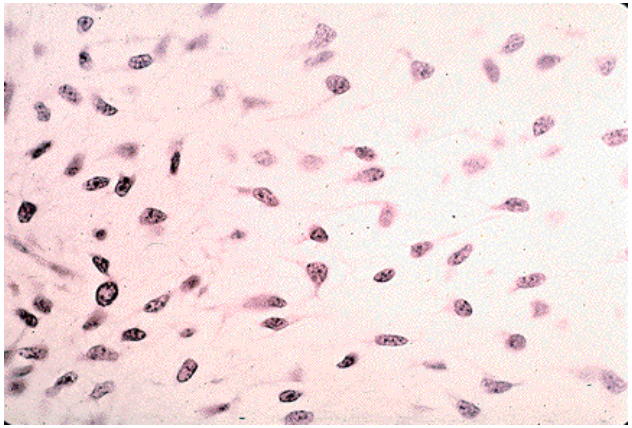


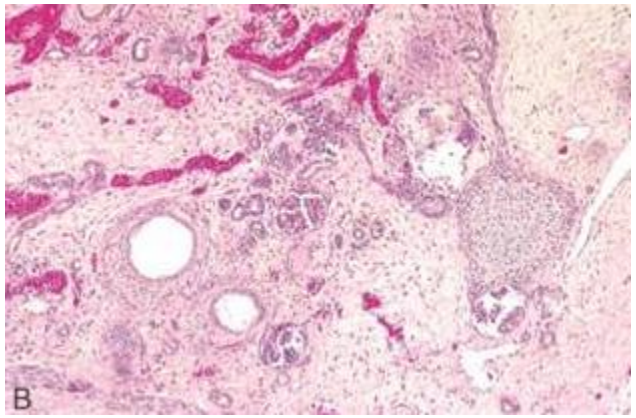
# CYSTIC DISEASES

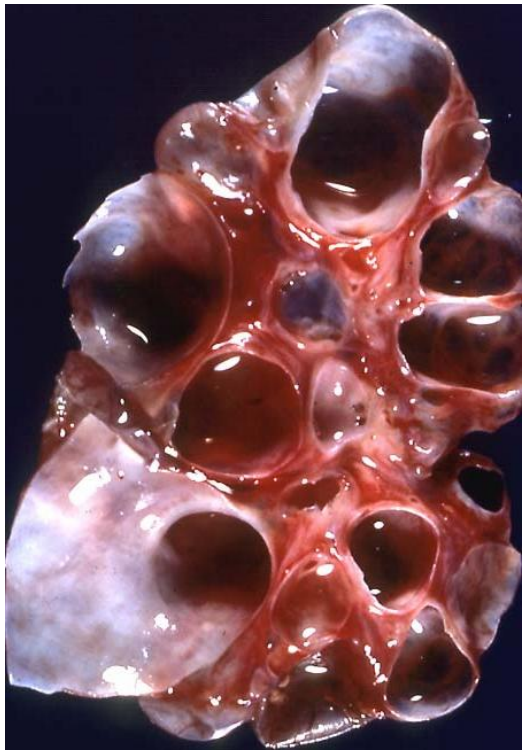
- CYSTIC RENAL "DYSPLASIA"
- **A**utosomal **D**OMINANT (**AD**-ULTS)
- Autosomal RECESSIVE (CHILDREN)
- MEDULLARY
  - Medullary Sponge Kidney (MSK)
  - Nephronopththisis-Medullary
- ACQUIRED
- SIMPLE

# CYSTIC RENAL "DYSPLASIA"

- ENLARGED
- UNILATERAL or BILATERAL
- CYSTIC
- Have "MESENCHYME"
- NEWBORNS
- VIRAL, GENETIC (rare)

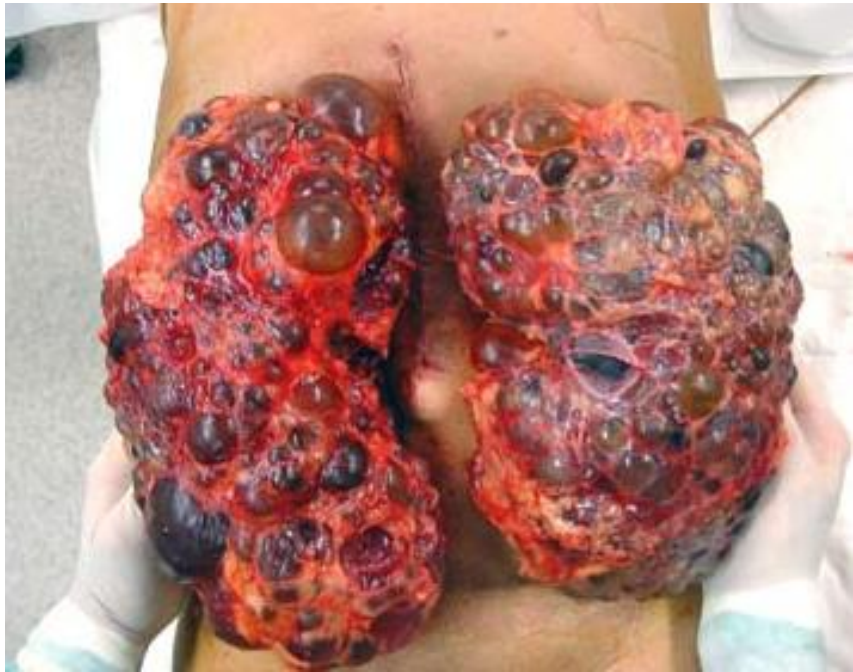






# AUTOSOMAL DOMINANT

- HEREDITARY, PKD1, PKD2
- FOLLOWS AUTOSOMAL DOMINANT PEDIGREE
- COMPLEX GENETICS
- RENAL FAILURE in 50's

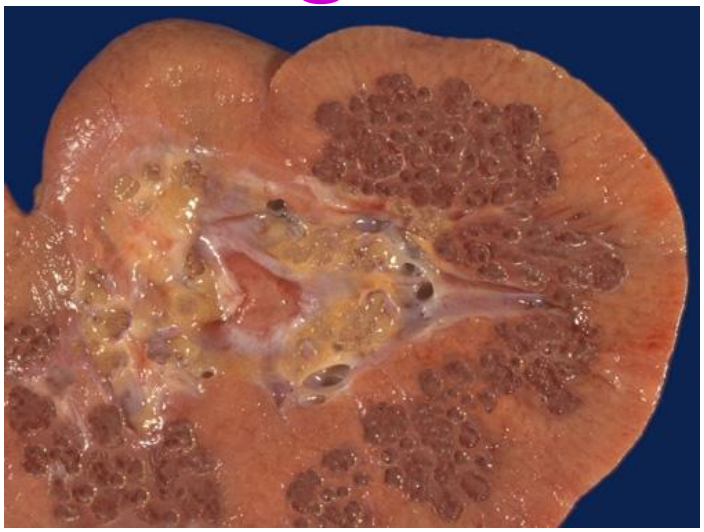


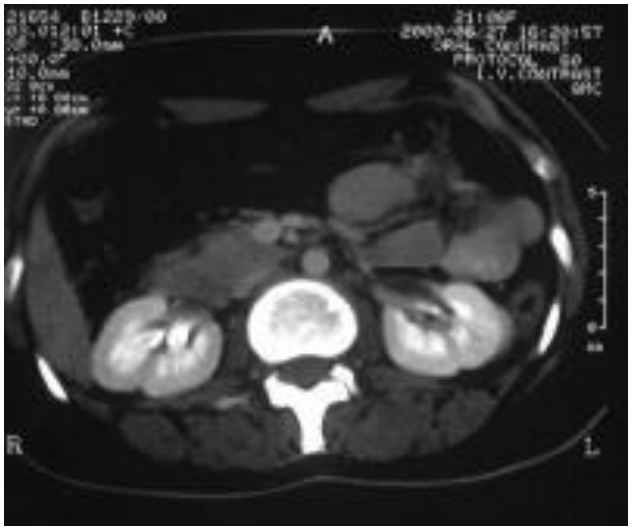
# AUTOSOMAL RECESSIVE

- CHILDHOOD
- KIDNEYS LOOK EXACTLY LIKE THE ADULT TYPE
- PKHD1
- PATIENTS WHO SURVIVE CHILDHOOD OFTEN DEVELOP HEPATIC FIBROSIS

# MEDULLARY CYSTS

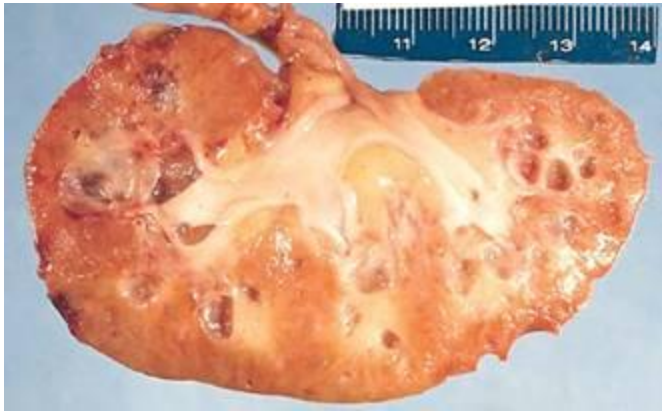
- MEDULLARY SPONGE KIDNEY (MSK), usually an incidental finding on CT or US





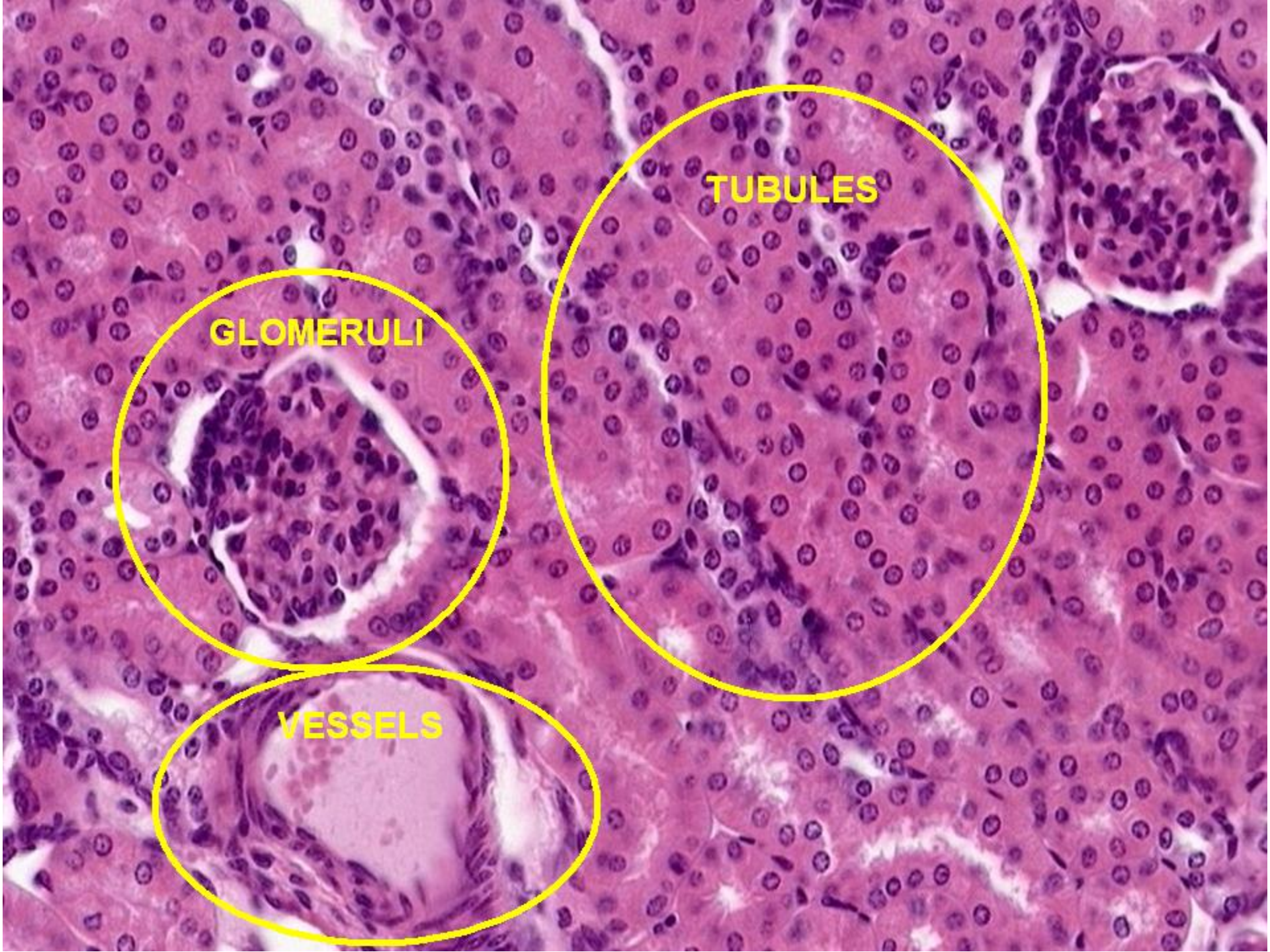
- NEPHRONOPHTHISIS, cysts @ CMJ, hereditary (AR), progressive

# ACQUIRED (DIALYSIS)



# “SIMPLE” CYSTS

- Cortical
- Also called “retention” cysts
- Also “acquired”
- Incidental, asymptomatic
- VERY very very common


TUBULES
GLOMERULI
VESSELS

# GLOMERULAR DISEASES

# CLINICAL MANIFESTATIONS

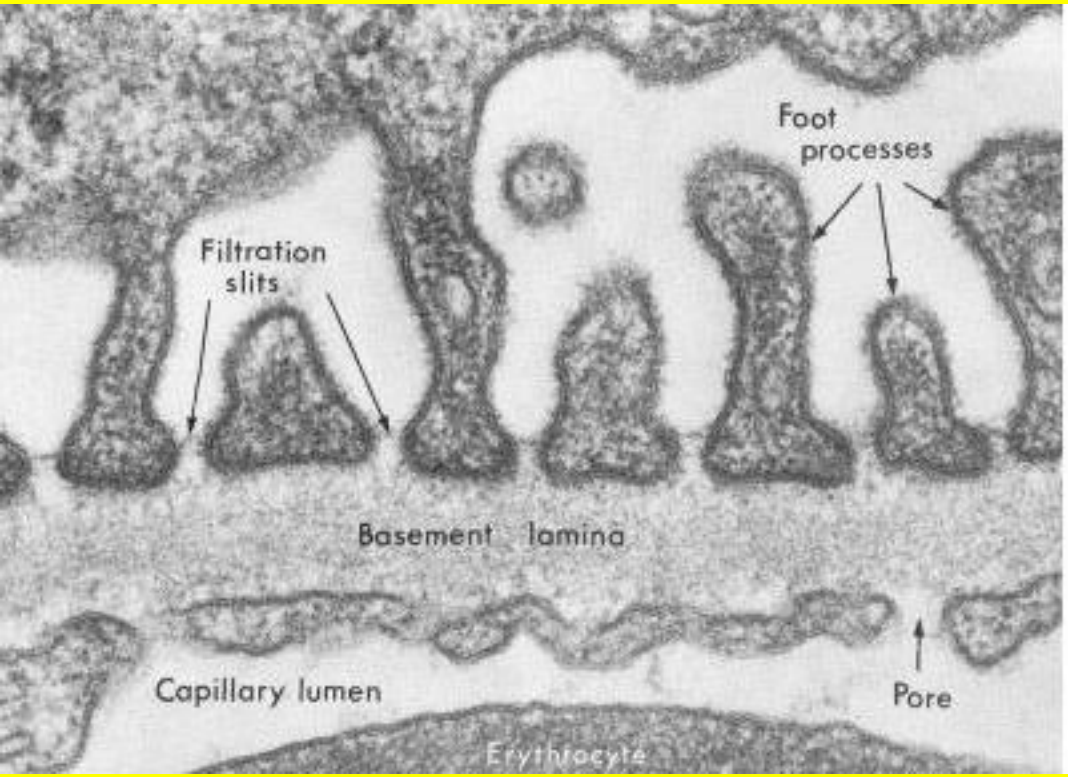
- ACUTE NEPHROTIC SYNDROME
- RAPIDLY PROGRESSIVE GLOMERULONEPHRITIS
- NEPHROTIC SYNDROME
- CHRONIC RENAL FAILURE
- ASYMPTOMATIC HEMATURIA or PROTEINURIA

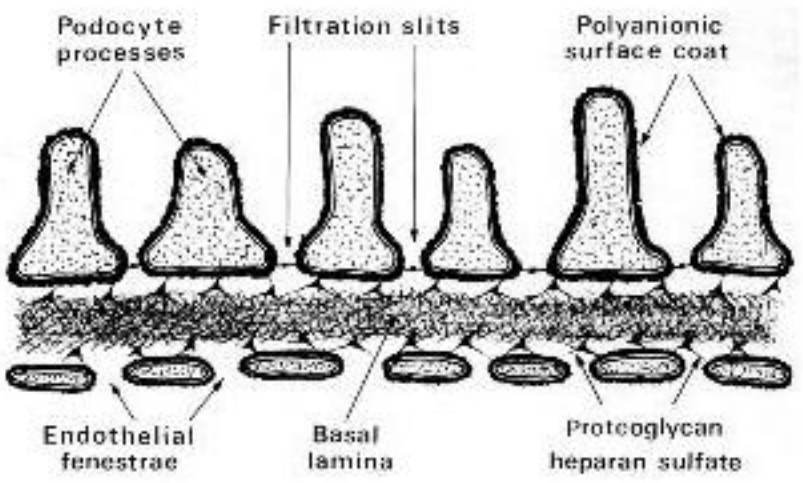
# PATHOLOGIC MANIFESTATIONS

- CELLULAR PROLIFERATION
  - Mesangial
  - Endothelial
- LEUKOCYTE INFILTRATION
- CRESCENTS (RAPIDLY progressive)
- BASEMENT MEMBRANE THICKENING
- HYALINIZATION
- SCLEROSIS

# PATHOGENESIS

- Antibodies against inherent GBM
- Antibodies against “planted” antigens
- Trapping of Ag-Ab complexes
- Antibodies against glomerular cells, e.g., mesangial cells, podocytes, etc.
- Cell mediated immunity, i.e., sensitized T-cells as in TB


Foot
processes
Filtration
slits
Basement lamina
Capillary lumen
Pore
Erythrocyte


Podocyte
processes
Filtration slits
Polyanionic
surface coat
Endothelial
fenestrae
Basal
lamina
Proteoglycan
heparan sulfate

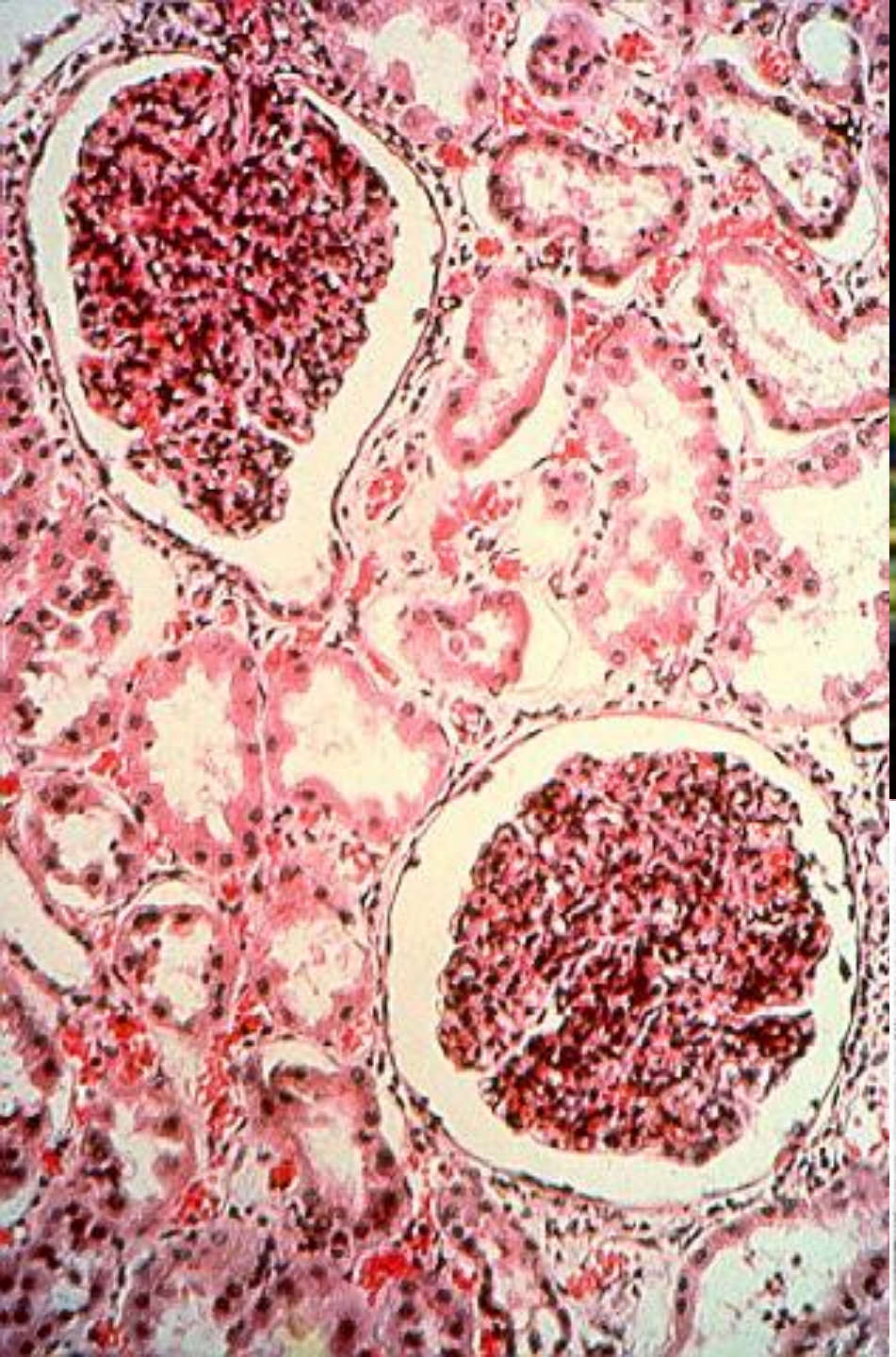
# MEDIATORS

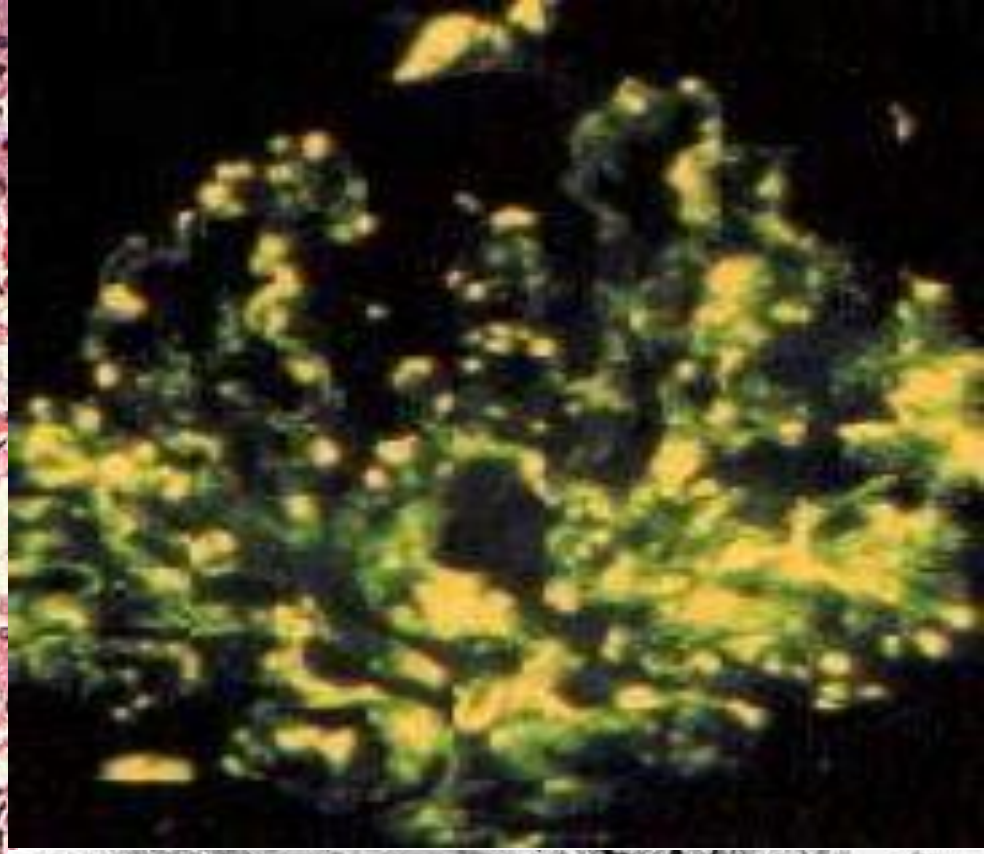
- NEUTROPHILS, MONOCYTES
- MACROPHAGES, T-CELLS, NK CELLS
- PLATELETS
- MESANGIAL CELLS

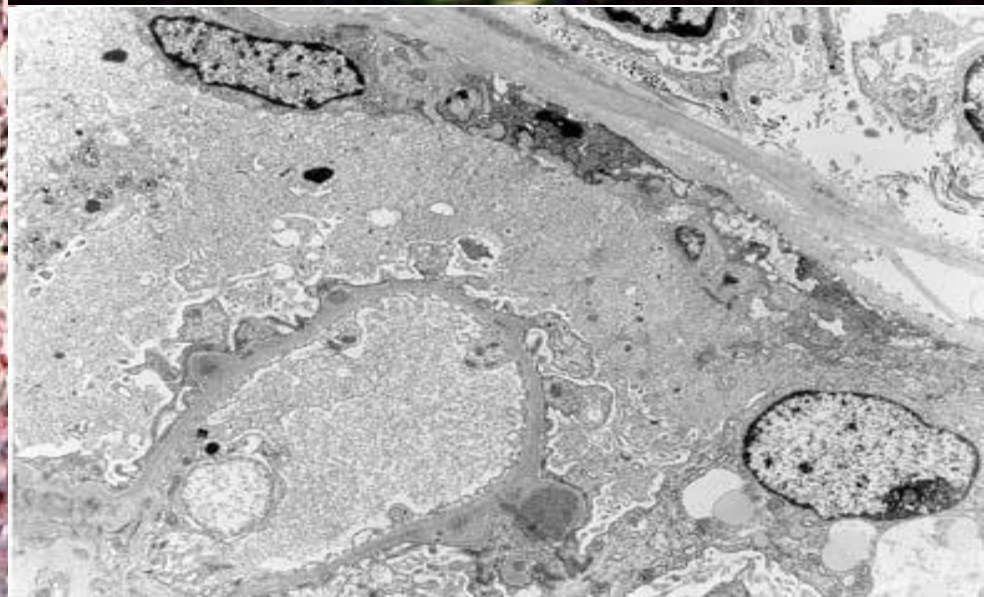
- **SOLUBLE:** CYTOKINES, CHEMOKINES, COAGULATION FACTORS

# ACUTE GLOMERULONEPHRITIS

- Hematuria, Azotemia, Oliguria, in children following a strep infection
- POSTSTREPTOCOCCAL (old term)
- HYPERCELLULAR GLOMERULI
- INCREASED ENDOTHELIUM AND MESANGIUM
- IgG, IgM, C3 along GMB FOCALLY
- 95% full recovery

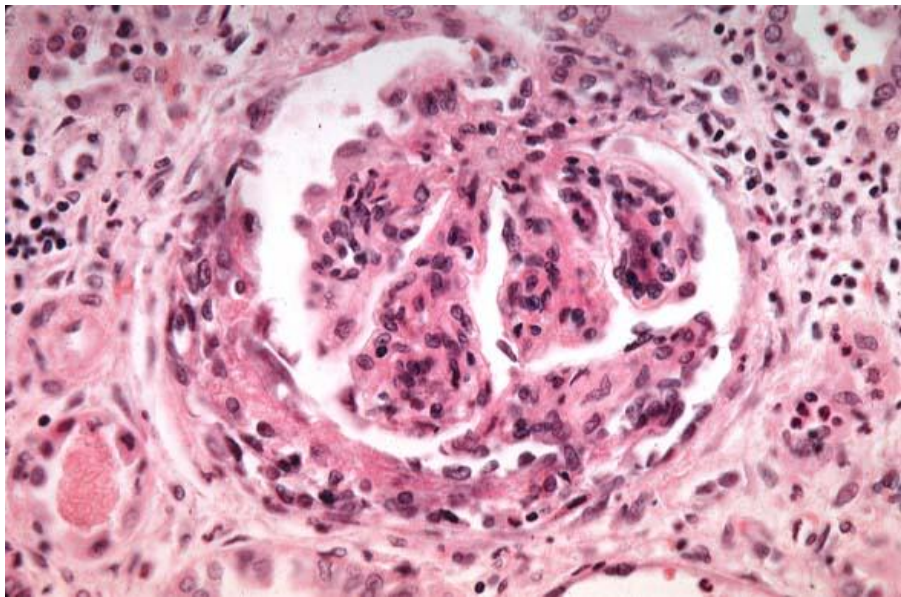






# RAPIDLY PROGRESSIVE GLOMERULONEPHRITIS

- Clinical definition, NOT a specific pathologic one
- "CRESCENTIC"
- Anti-GBM Ab
- IMMUN CPLX
- Anti-Neut. Ab

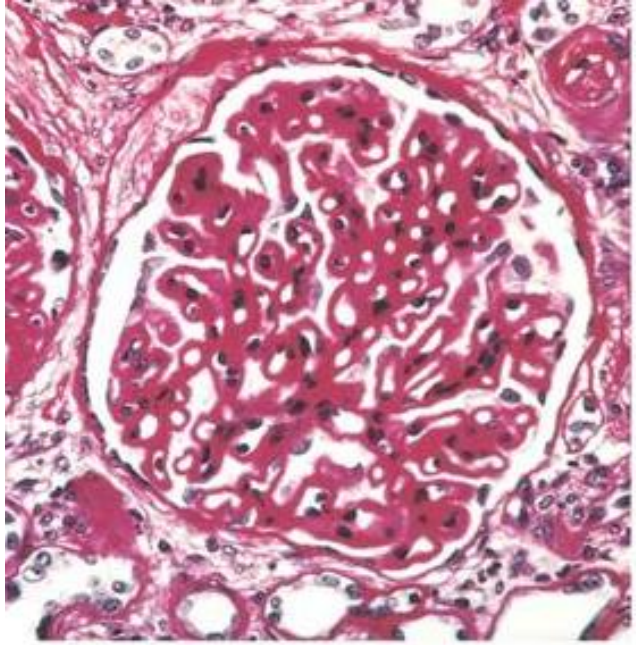


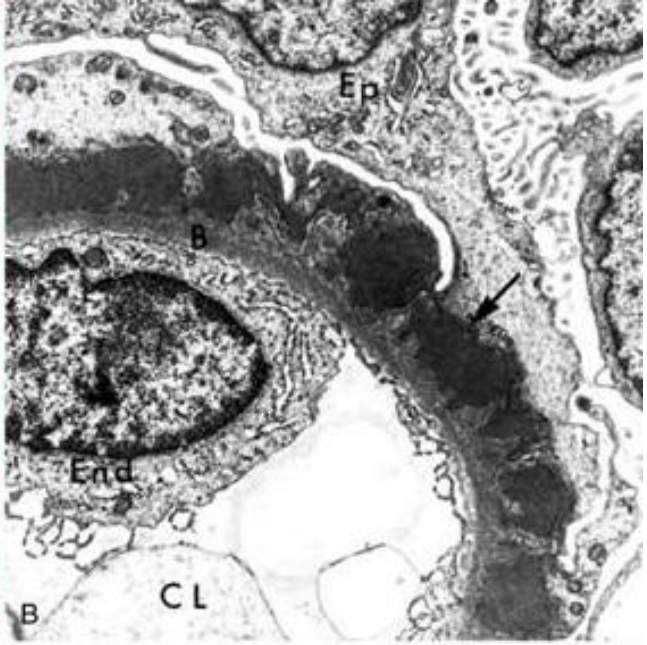
# NEPHROTIC SYNDROME

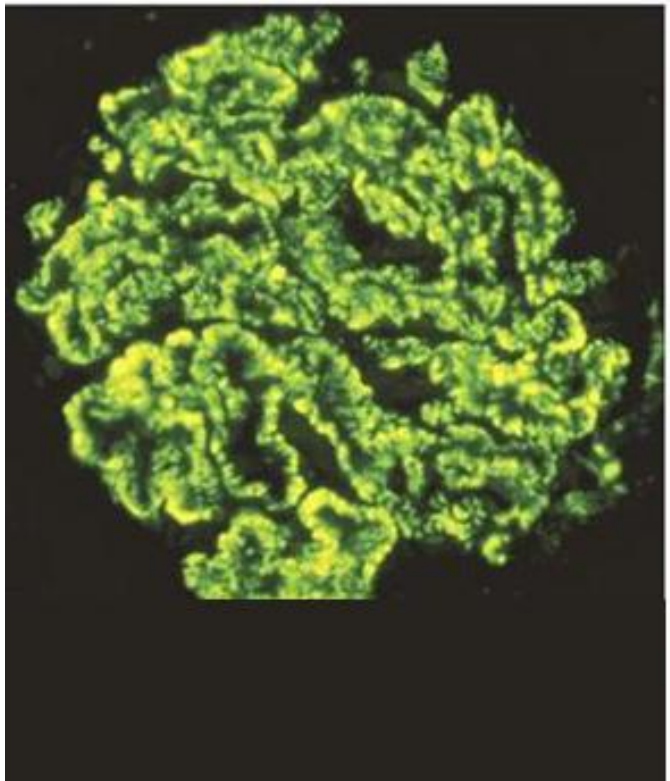
- MASSIVE PROTEINURIA
- HYPOALBUMINEMIA
- EDEMA
- LIPIDEMIA/LIPIDURIA
- NUMEROUS CAUSES:
  - MEMBRANOUS, MINIMAL CHANGE, FOCAL SEGMTL.
  - DIABETES, AMYLOID, SLE, DRUGS

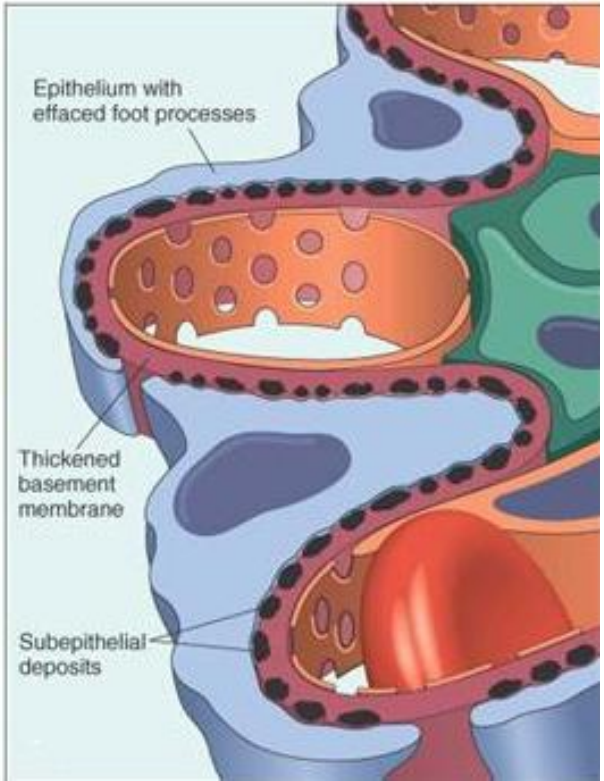
# MEMBRANOUS GLOMERULONEPHRITIS

- Drugs, Tumors, SLE, Infections
- Deposition of Ag-Ab complexes
- Indolent, but >60% persistent proteinuria
- 15% go on to nephrotic syndrome



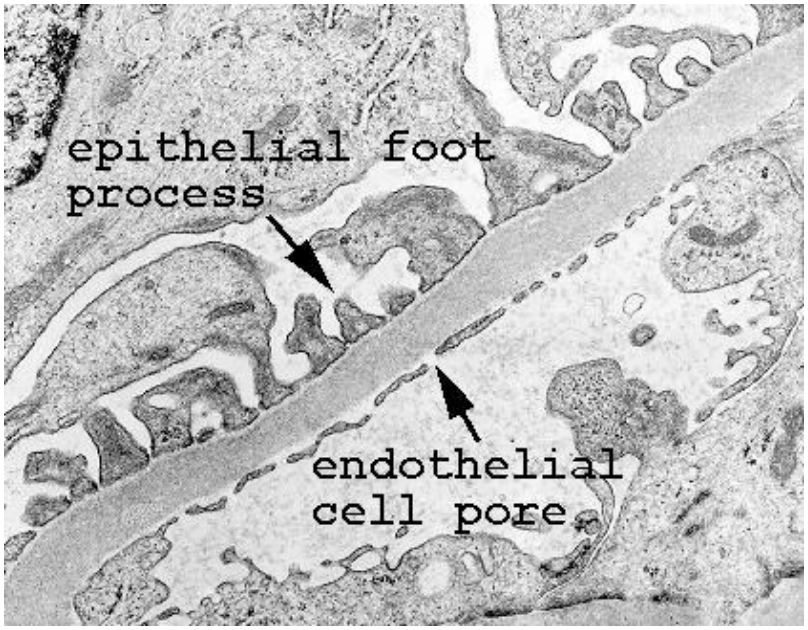

Ep
B
End
CL
B

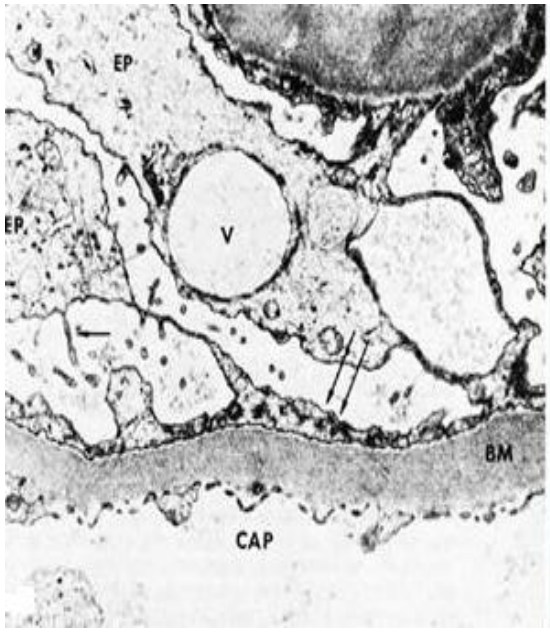


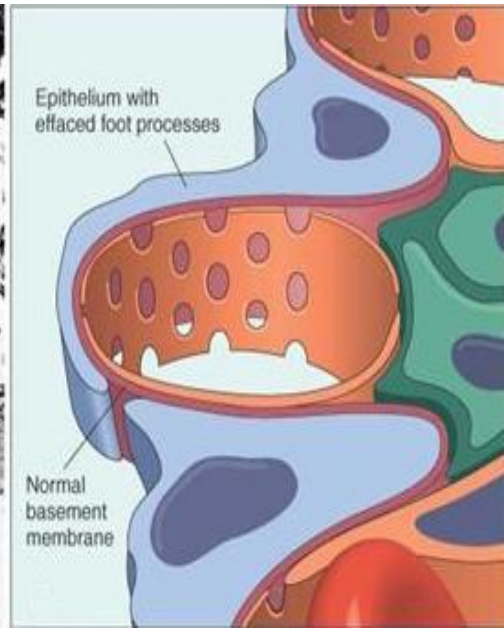

Epithelium with
effaced foot processes
Thickened
basement
membrane
Subepithelial
deposits

# MINIMAL CHANGE GLOM. (LIPOID NEPHROSIS)

- **MOST COMMON CAUSE of NEPHROTIC SYNDROME in CHILDREN**
- **EFFACEMENT of FOOT PROCESSES**

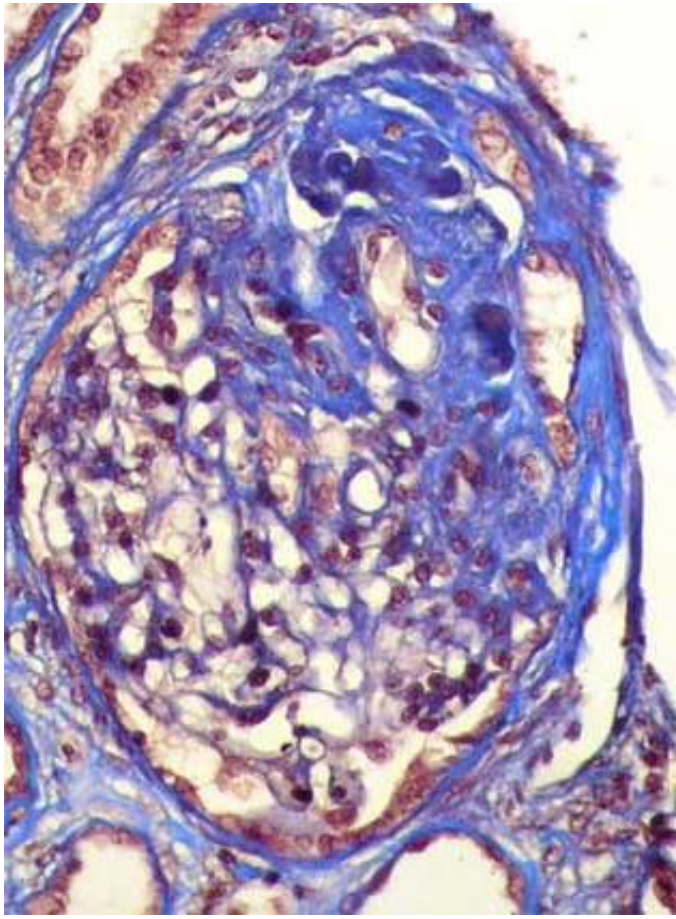


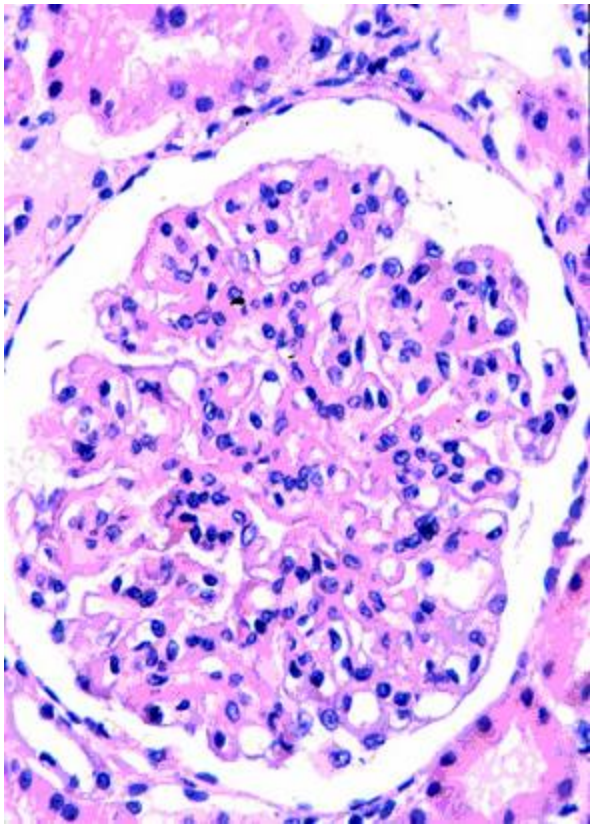
# FOCAL SEGMENTAL GLOMERULO-SCLEROSIS

- Just like its name
  - Focal
  - Segmental
  - Glomerulo-SCLEROSIS (NOT –itis)
- HIV, Heroine, Sickle Cell, Obesity
- Most common cause of ADULT nephrotic syndrome



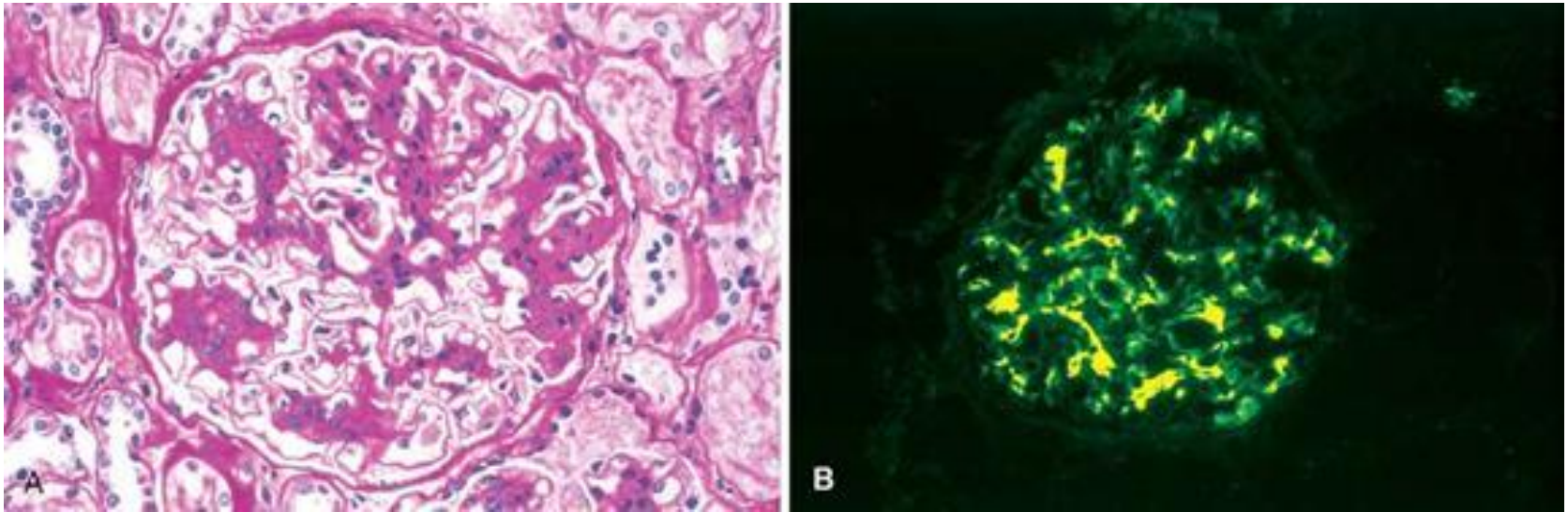
# MEMBRANOPROLIFERATIVE GLOMERULONEPHRITIS

- MPGN can be idiopathic or 2º to chronic immune diseases Hep-C, alpha-1-antitrypsin, HIV, Malignancies
- GBM alterations, subendo.
- Leukocyte infiltrations
- Predominant MESANGIAL involvement



# IgA NEPHROPATHY (BERGER DISEASE)

- Mild hematuria
- Mild proteinuria
- IgA deposits in mesangium



# HEREDITARY HEMATURIA SYNDROMES

- **ALPORT SYNDROME**
  - **Progressive Renal Failure**
  - **Nerve Deafness**
  - **VARIOUS eye disorder**
  - **DEFECTIVE COLLAGEN TYPE IV**

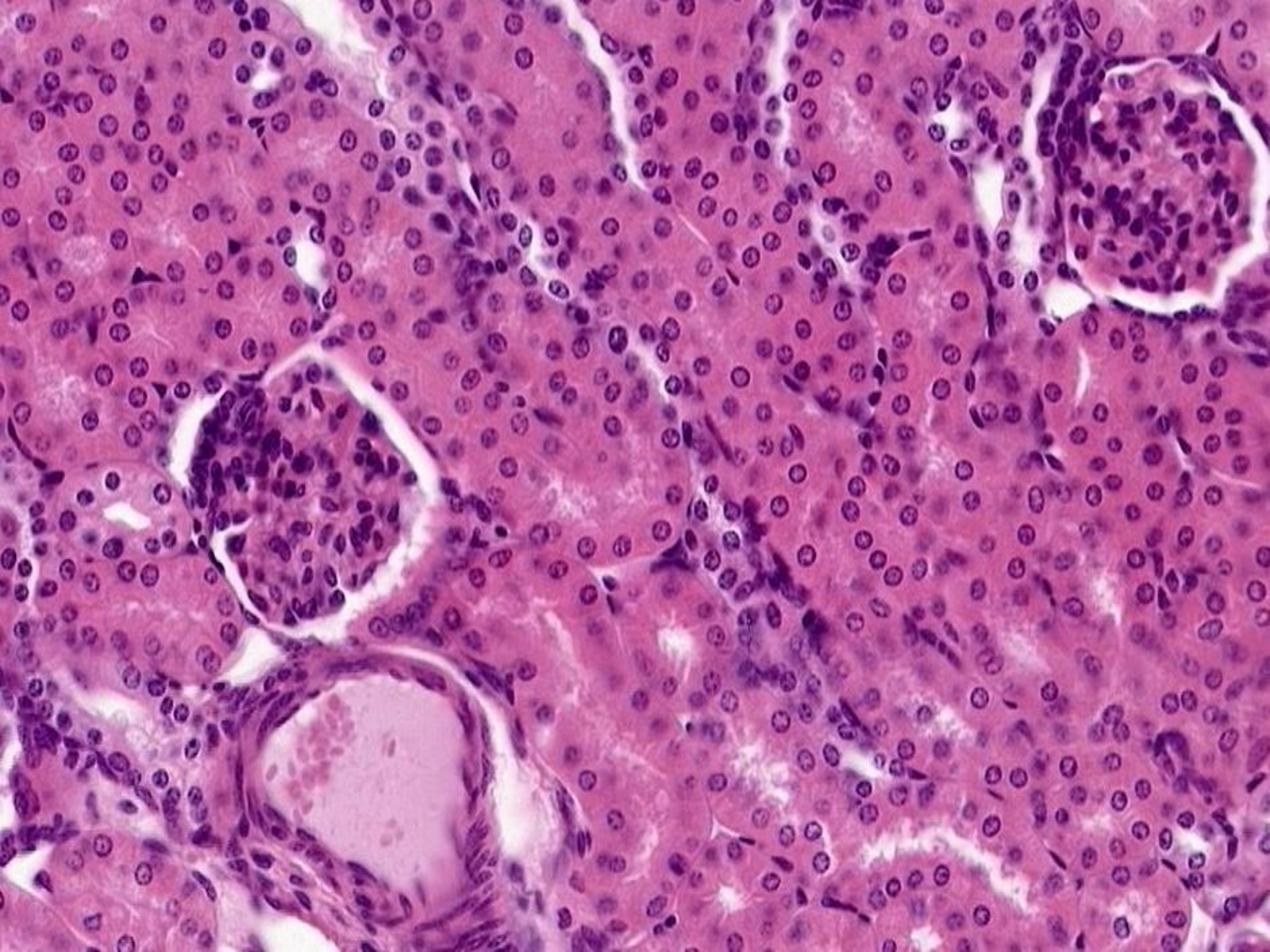
- **THIN GBM (Glomerular Basement Membrane) Disease, i.e., about HALF as uniformly thin as it should be**

# CHRONIC GLOMERULONEPHRITIS

- Can result from just about ANY of the previously described acute ones
  - THIN CORTEX
  - HYALINIZED (fibrotic) GLOMERULI
  - OFTEN SEEN IN DIALYSIS PATIENTS

# SECONDARY (2º) GLUMERULONEPHROPATHIES

- **SLE**
- **Henoch-Schonlein Purpura (IgA-NEPH)**
- **BACTERIAL ENDOCARDITIS**
- **DIABETES (Nodular Glomerulosclerosis, or K-W Kidney)**
- **AMYLOIDOSIS**
- **GOODPASTURE**
- **WEGENER**
- **MYELOMA**



TUBULES

INTERSTITIUM

BLOOD VESSELS

OBSTRUCTION

TUMORS

# TUBULAR DISEASES

- ACUTE TUBULAR NECROSIS
- TUBULOINTERSTITIAL NEPHRITIS
  - PYELONEPHRITIS
    - ACUTE
    - CHRONIC
  - DRUGS
  - TOXINS
- URATE NEPHROPATHY
- HYPERCALCEMIA/NEPHROCALCINOSIS
- MULTIPLE MYELOMA

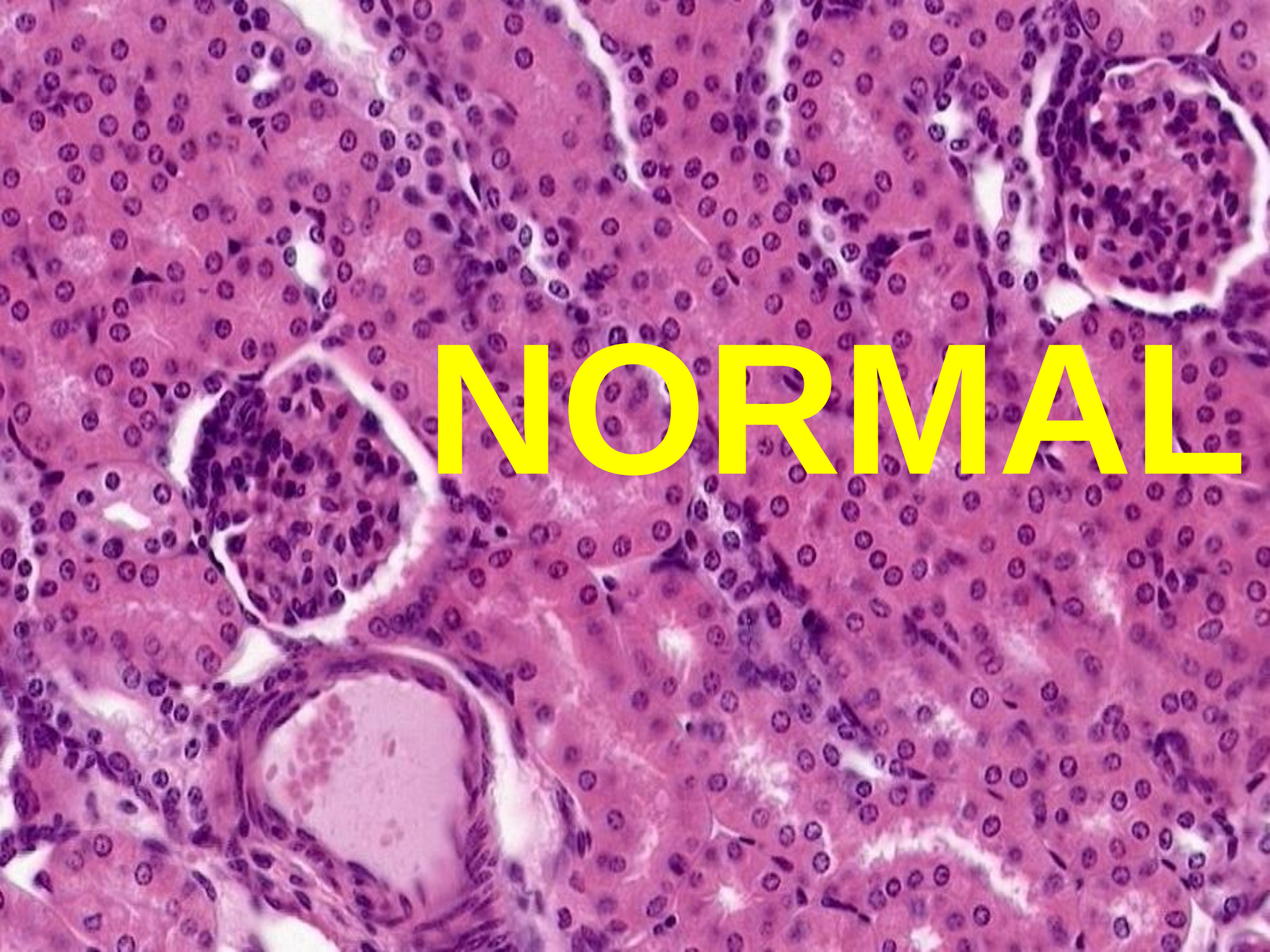
# ACUTE TUBULAR NECROSIS

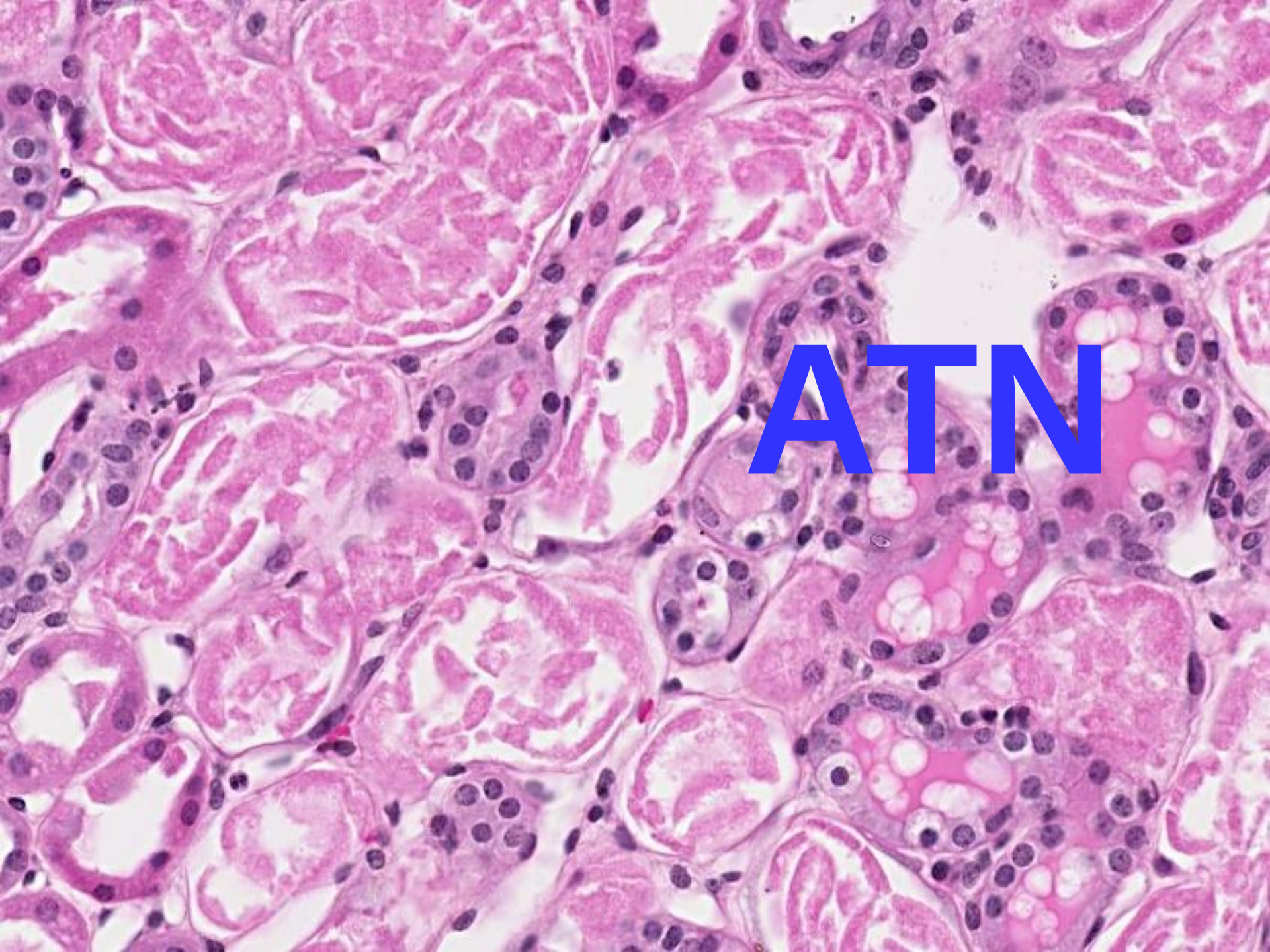
- Destruction of renal TUBULAR epithelium
- Loss of renal function
- 50% of ACUTE renal failure
- Two types:

**ISCHEMIC**

**NEPHROTOXIC**

- AMINOGLYCOSIDES
- AMPHOTERICIN B
- CONTRAST AGENTS


NORMAL


ATN

# ATN PATHOGENESIS

- BLOOD FLOW DISTURBANCES (ISCHEMIC)
- TUBULAR INJURY (NEPHROTOXIC)

# CLINICAL COURSE

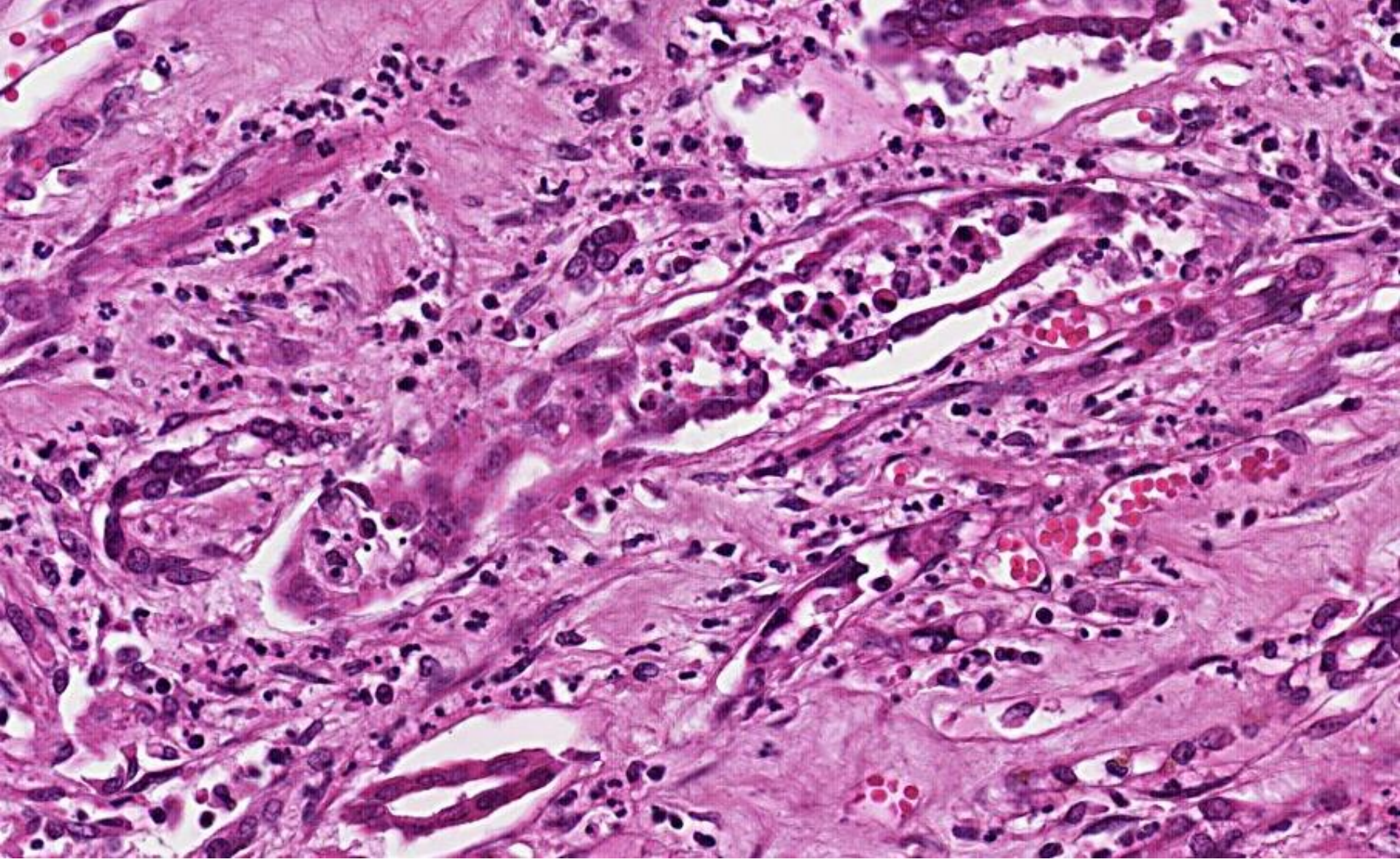
- **INITIATION (36 hours)**
  - **Mild OLIGURIA**
  - **Mild AZOTEMIA**
- **MAINTENANCE**
  - **More OLIGURIA**
  - **More AZOTEMIA**
  - **DIALYSIS NEEDED**
- **RECOVERY**
  - **HYPOKALEMIA main problem**
  - **BUN, CREATININE return to normal**

# TUBULO/INTERSTITIAL NEPHRITIS

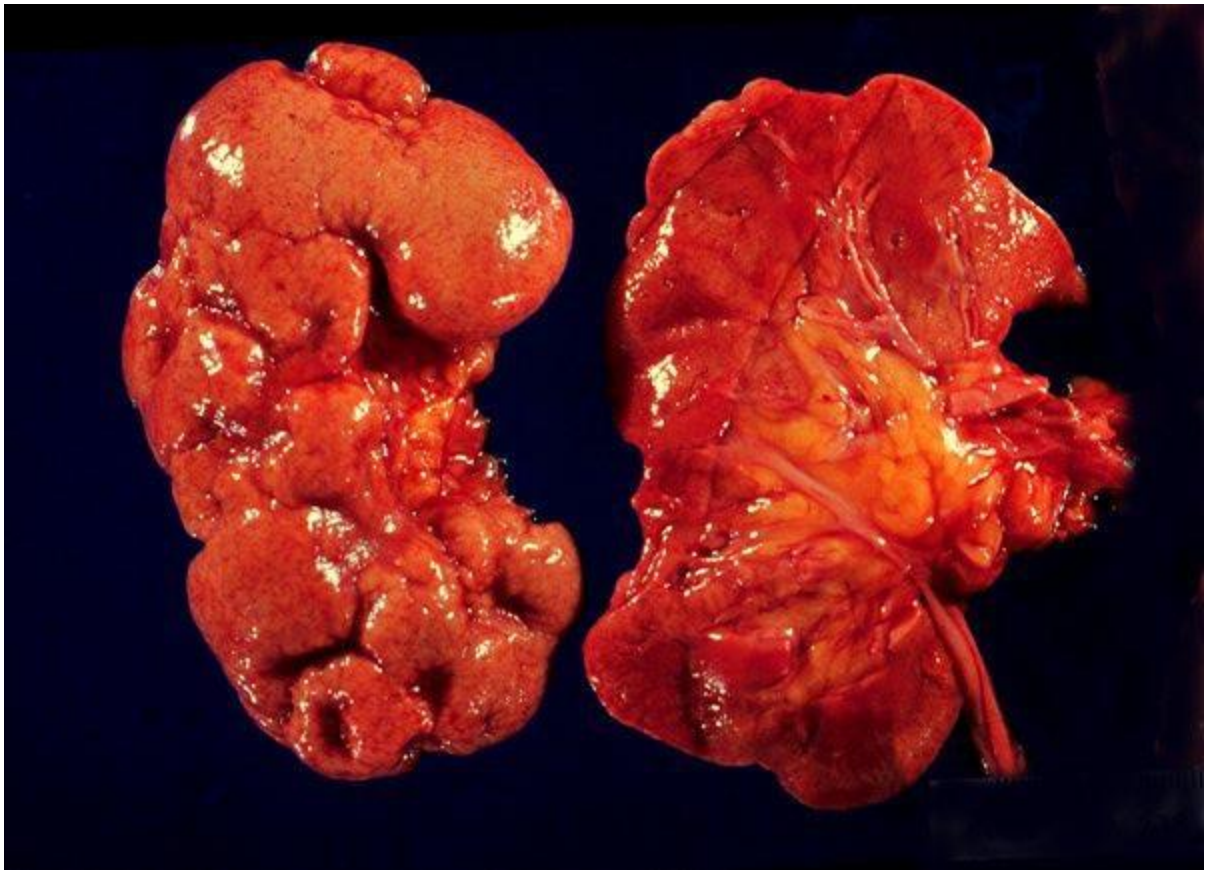
- INFECTIONS, i.e., pyelonephritis
- TOXINS, heavy metals, chemo, NSAIDS
- METABOLIC, urates, Ca++, Oxalates
- PHYSICAL, obstruction, radiation
- IMMUNOLOGIC, esp. transplant rejection

# PYELONEPHRITIS

- GI Gram NEGATIVES: E. COLI, Proteus, Klebsiella, Enterobacter, Strep. faecalis, usually “NORMAL” flora
- ASCENDING, by FAR, the most common, i.e., reflux, obstruction
- HEMATOGENOUS too
- ACUTE PYELONEPHRITIS, neutrophils
- CHRONIC PYELONEPHRITIS, lymphocytes, scars



**ACUTE or CHRONIC PYELONEPHRITIS?**



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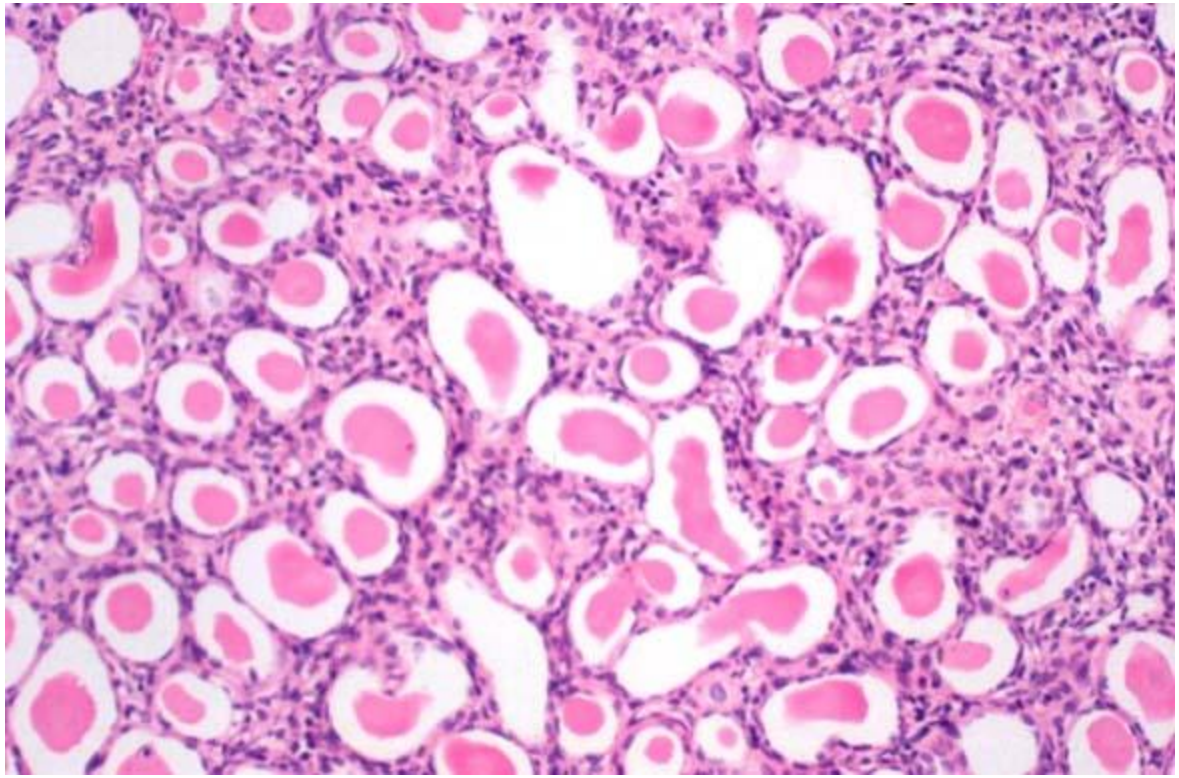


**ACUTE or CHRONIC PYELONEPHRITIS?**

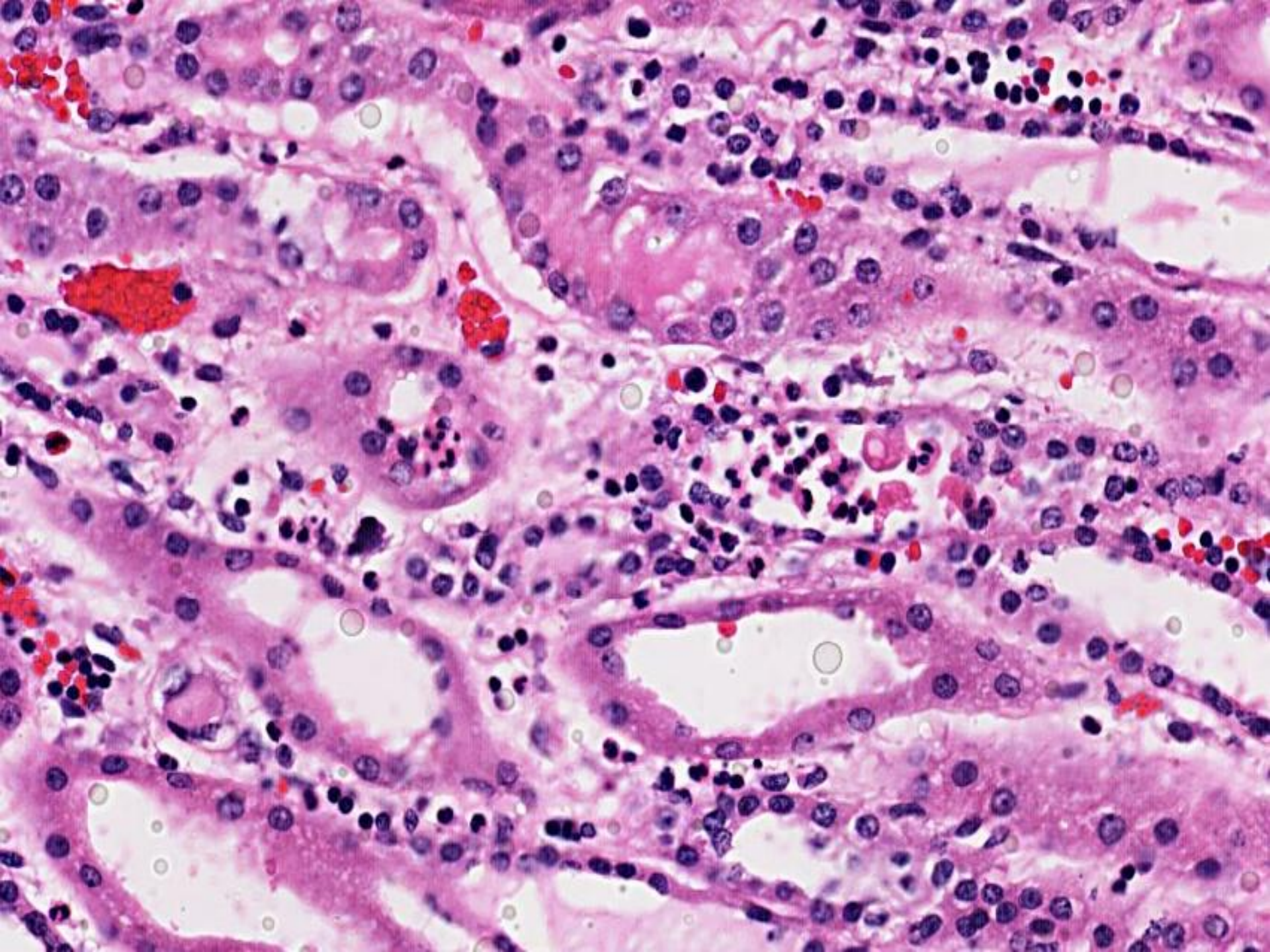
# FACTORS

- **OBSTRUCTION: Congenital or Acquired**
- **INSTRUMENTATION**
- **VESICOURETERAL REFLUX**
- **PREGNANCY**
- **AGE, SEX, why sex?  F>>>M**
- **PREVIOUS LESIONS**
- **IMMUNOSUPPRESION or IMMUNODEFICIENCY**

# DRUGS/TOXINS causing INTERSTITIAL NEPHRITIS

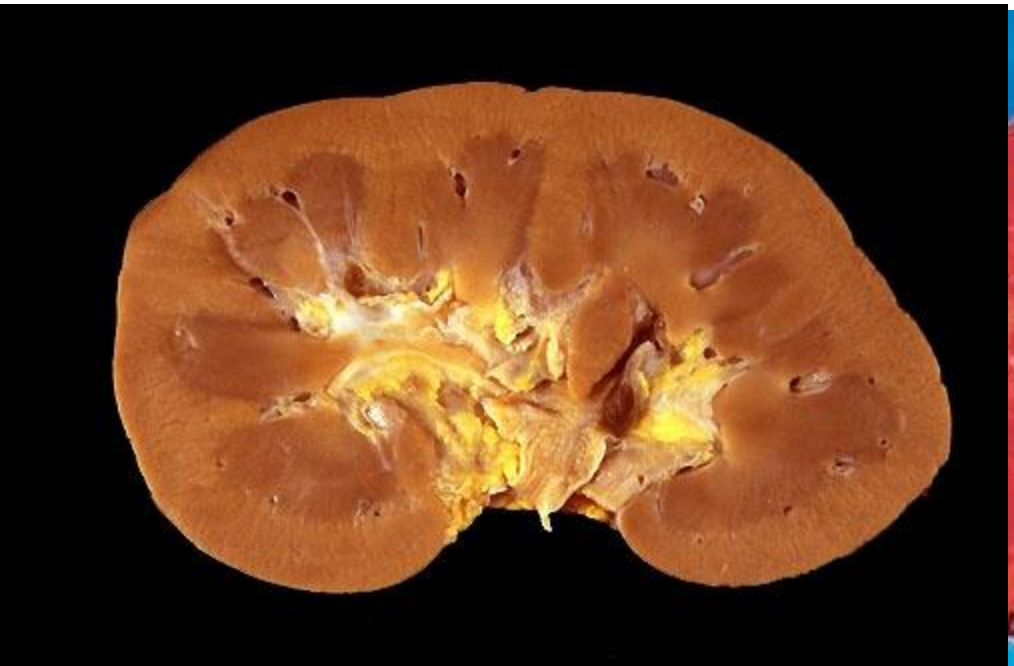
- Synthetic Penicillins
- Rifampin
- Thiazides

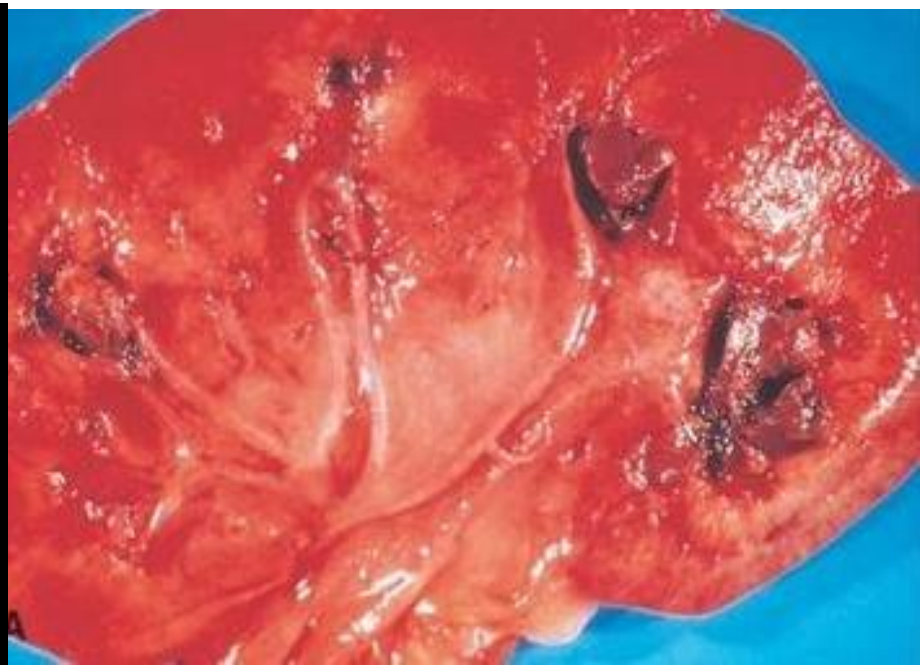
- 2 weeks later: Fever, eosinophilia, rash, and an acute renal failure type of picture



# ANALGESIC NEPHROPATHY

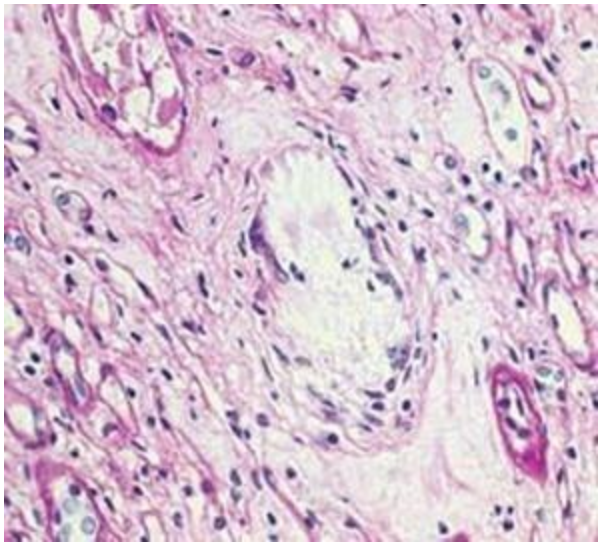
- ASPIRIN, TYLENOL, NSAIDS
  - TUBULOINTERSTITIAL NEPHRITIS
  - PAPILLARY NECROSIS (also Dm & HbS)



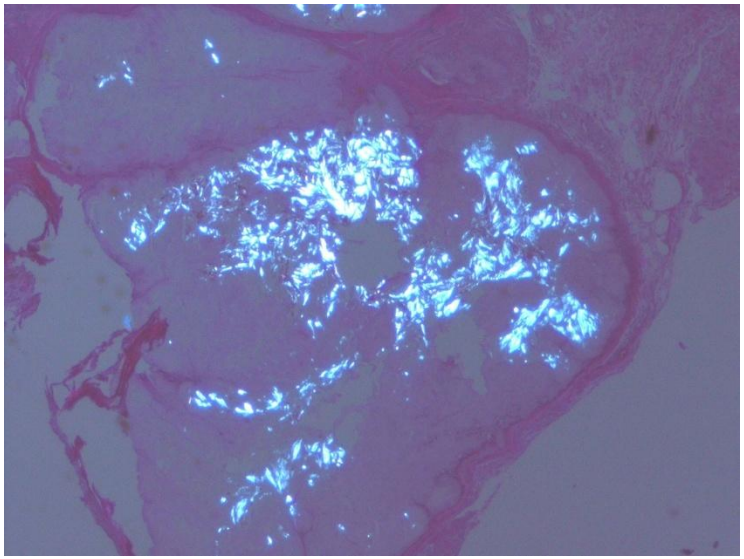


# URATE NEPHROPATHY

- **Precipitation of Uric Acid Crystals in the TUBULES, especially in a LOWER than usual PH situation (mini-TOPHUS)**



H & E alcohol fixed



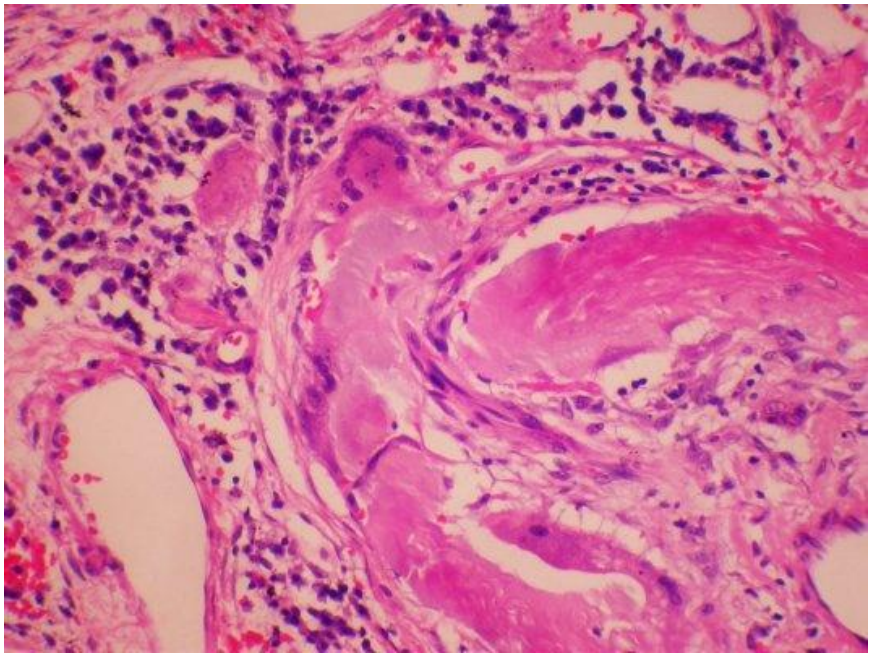
POLARIZED LIGHT MICROSCOPY

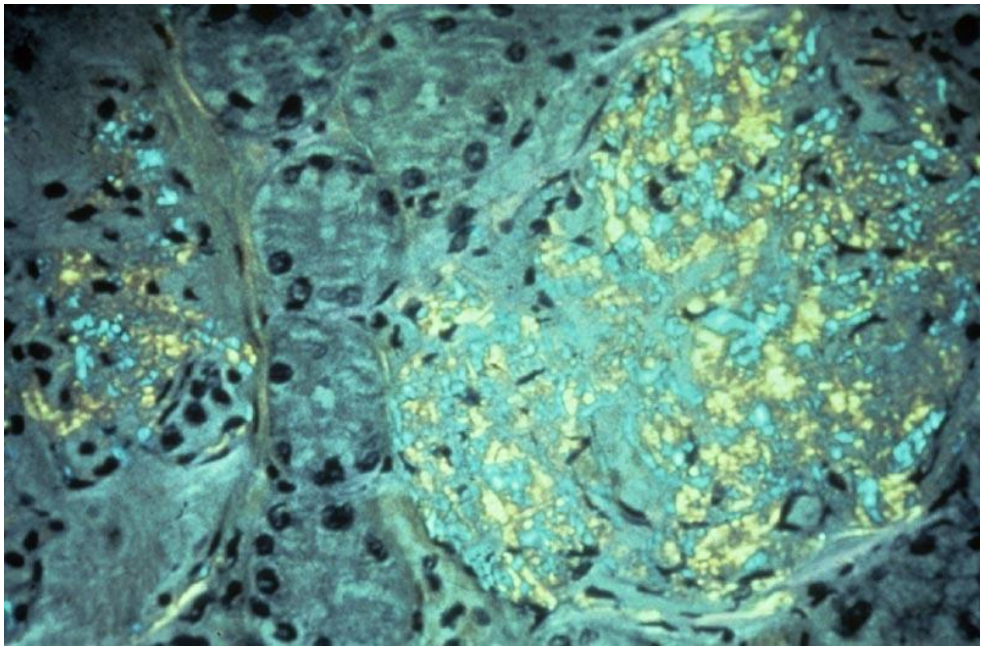
# HYPERCALCEMIA NEPHROCALCINOSIS

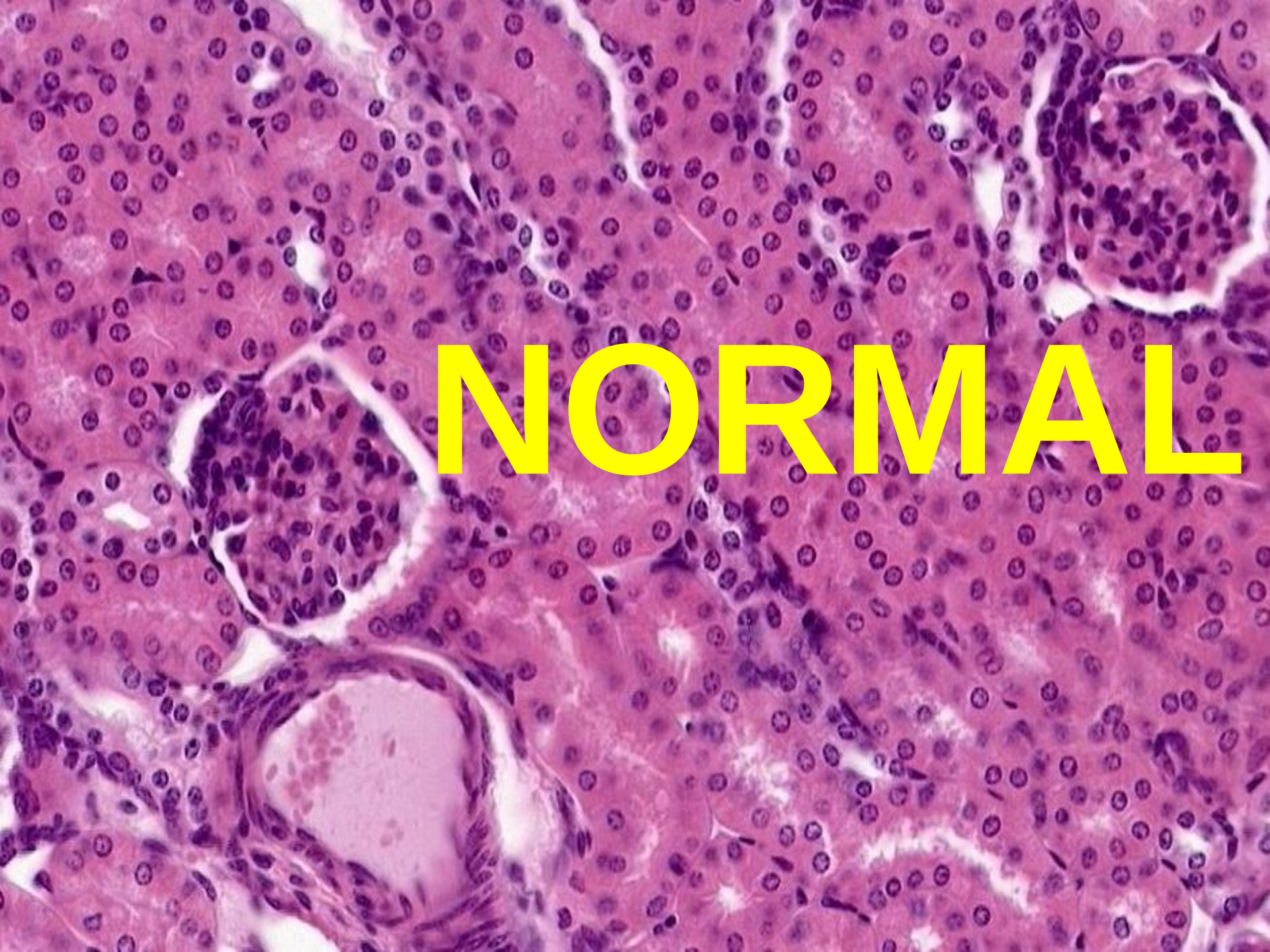
**PRINCIPLE: In extreme or uncontrolled or chronic HYPERCALCEMIA, calcium stones form in the tubulo-interstitium of the kidney, which can eventually lead to tubular obstruction and loss of function**

# MULTIPLE MYELOMA

- **Bence Jones proteinuria (immunoglobulin light chains)**
- **AMYLOIDOSIS**





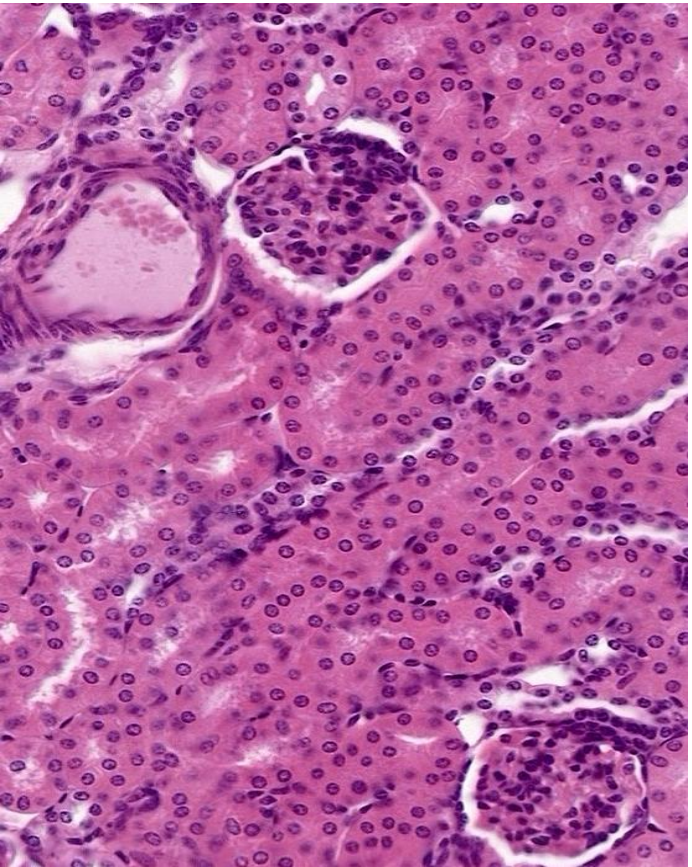

NORMAL

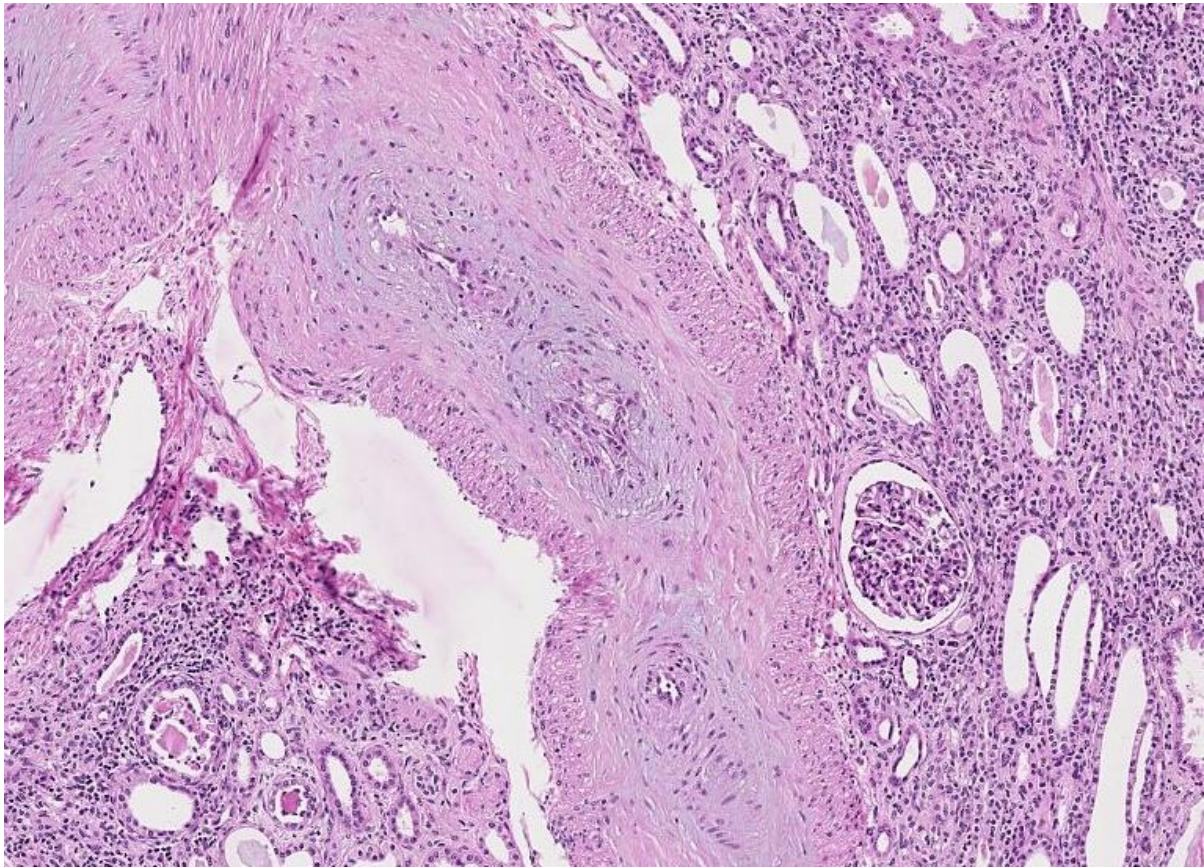
# VASCULAR DISEASES

- BENIGN NEPHROSCLEROSIS
- MALIGNANT NEPHROSCLEROSIS (i.e., malignant hypertension)
- RENAL ARTERY STENOSIS
- THROMBOTIC MICROANGIOPATHIES
  - Hemolytic-Uremic Syndromes, Child, Adult, TTP
- THROMBI, EMBOLI, INFARCTS
  - SICKLE CELL
  - DIFFUSE CORTICAL NECROSIS

# BENIGN NEPHROSCLEROSIS

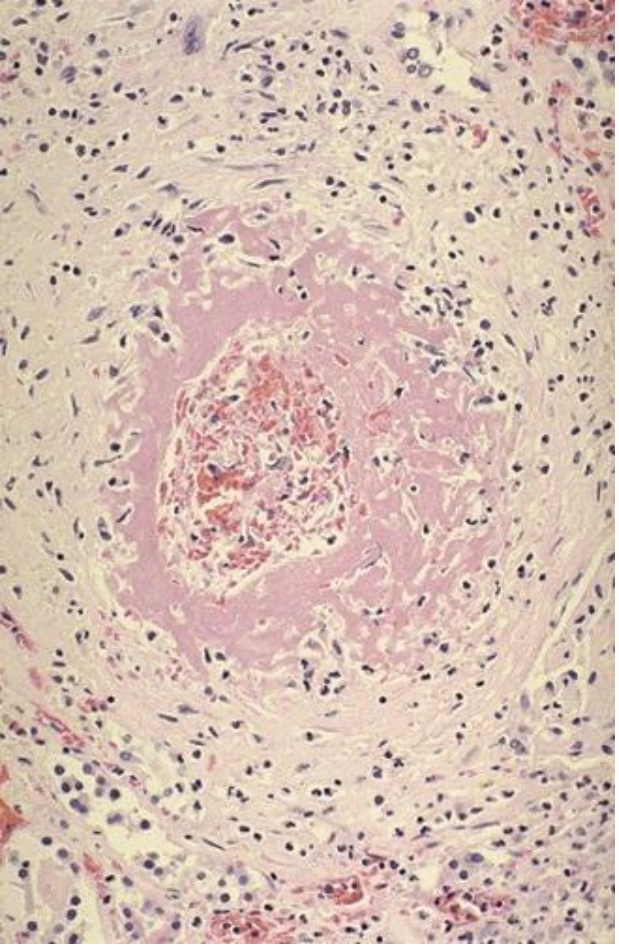
- Sclerosis, i.e., “hyalinization” of arterioles and small arteries, i.e., arterio-, arteriolo-
- Is this part of “routine” atherosclerosis????
- VERY VERY VERY common

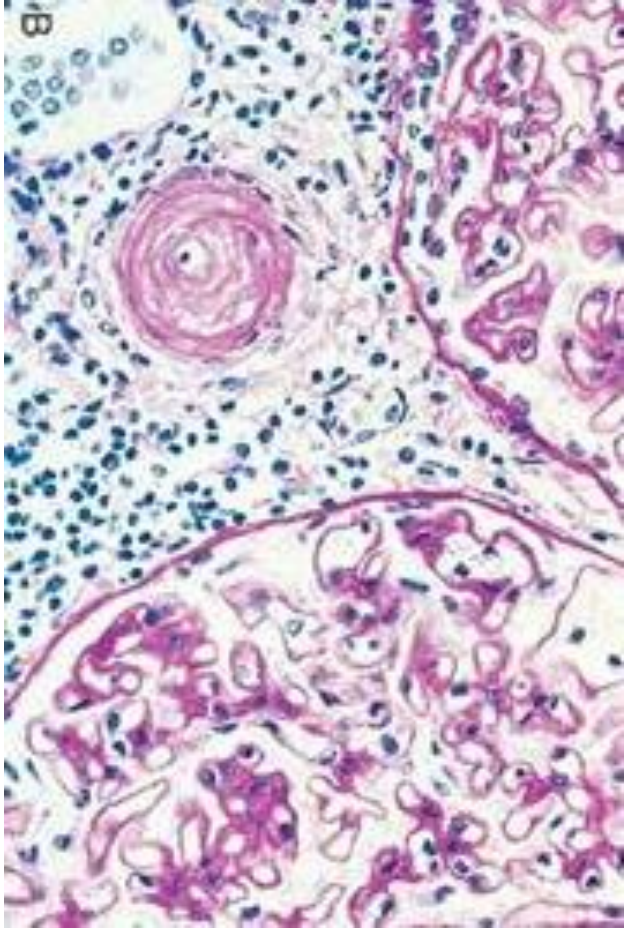




# MALIGNANT NEPHROSCLEROSIS (i.e., malignant hypertension)

- NOT a part of “routine” atherosclerosis
- By definition, associated with rapidly progressive hypertension (1-2% of HTN)
- VASCULAR DAMAGE
- FIBRINOID NECROSIS
- “ONION SKINNING”
- SIGNIFICANT LUMENAL NARROWING





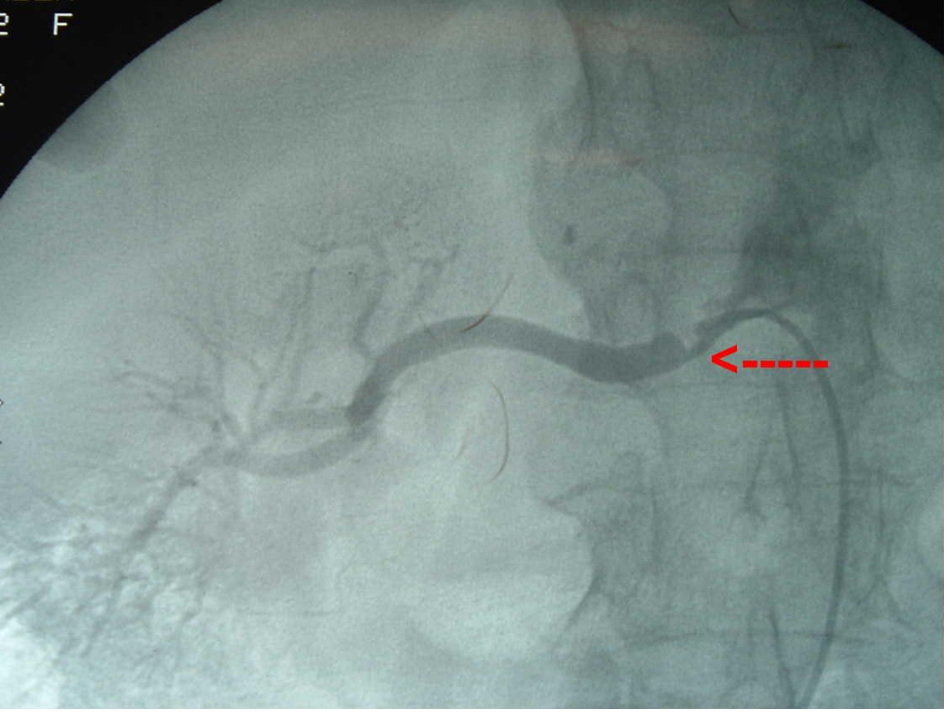
**What is “onion-skinning”?**

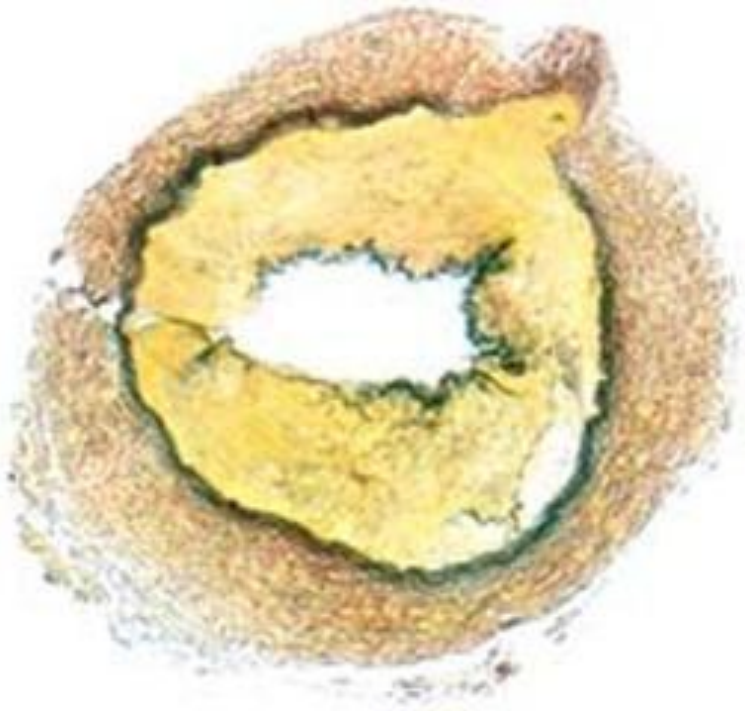
**What is an onion?**

**What is “fibrinoid” necrosis?**

# Renal Artery Stenosis

- **Rare cause of HTN**
- **SMALL Kidney**
- **1) Plaque type is usual cause, yes regular old atherosclerosis**
- **2) Fibromuscular "dysplasia" type:**
  - **INTIMAL HYPERPLASIA**
  - **MEDIAL HYPERPLASIA**
  - **ADVENTITIAL HYPERPLASIA**
  - In younger women





**PLAQUE**, i.e.,

**ATHEROSCLEROSIS**

**FIBROMUSCULAR**

**DYSPLASIA**

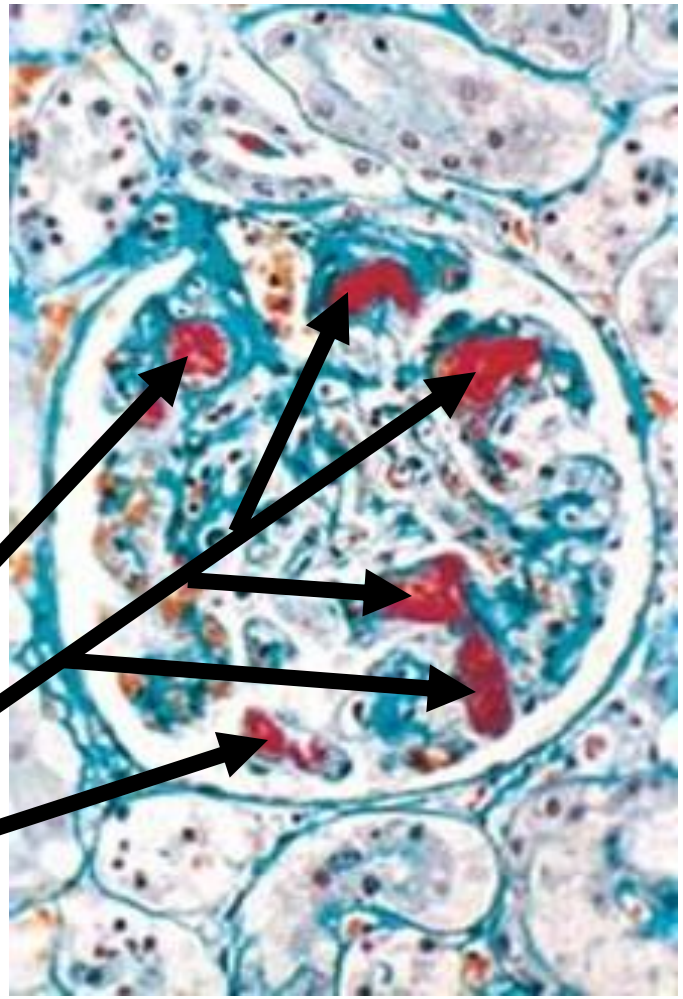
# MICROANGIOPATHIES (thrombotic)

- Hemolytic-Uremic Syndrome
  - Familial
  - Childhood
  - Adult
- TTP (Thrombotic Thrombocytopenic Purpura), IDIOPATHIC

# MICROANGIOPATHIES

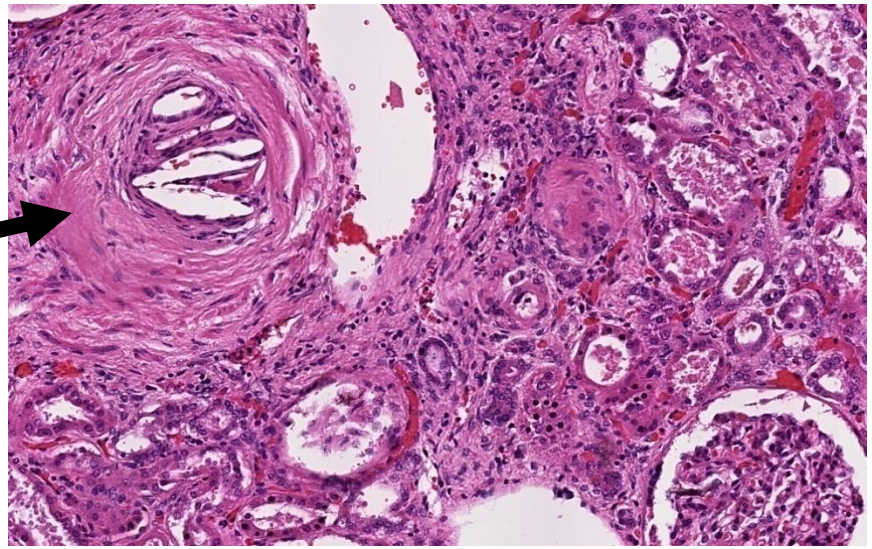
## COMMON PROCESSES

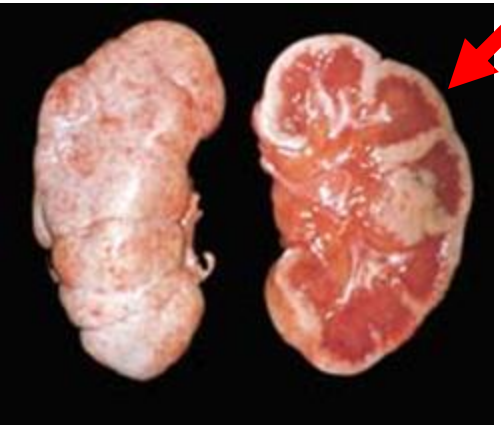
- Hemolysis
- Thromboses in renal capillaries
- Thrombocytopenia (a "consumption" coagulopathy)
- FIBRIN PLUGS

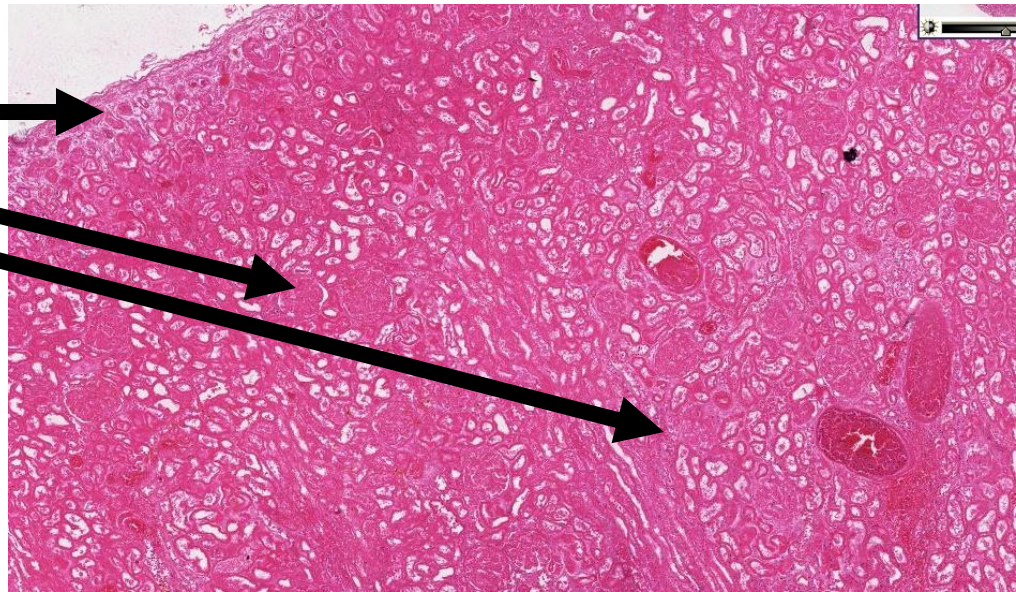


# OTHER VASCULAR

- Atherosclerosis
- Atheroemboli
- Sickle Cell
- Diffuse Cortical Necrosis

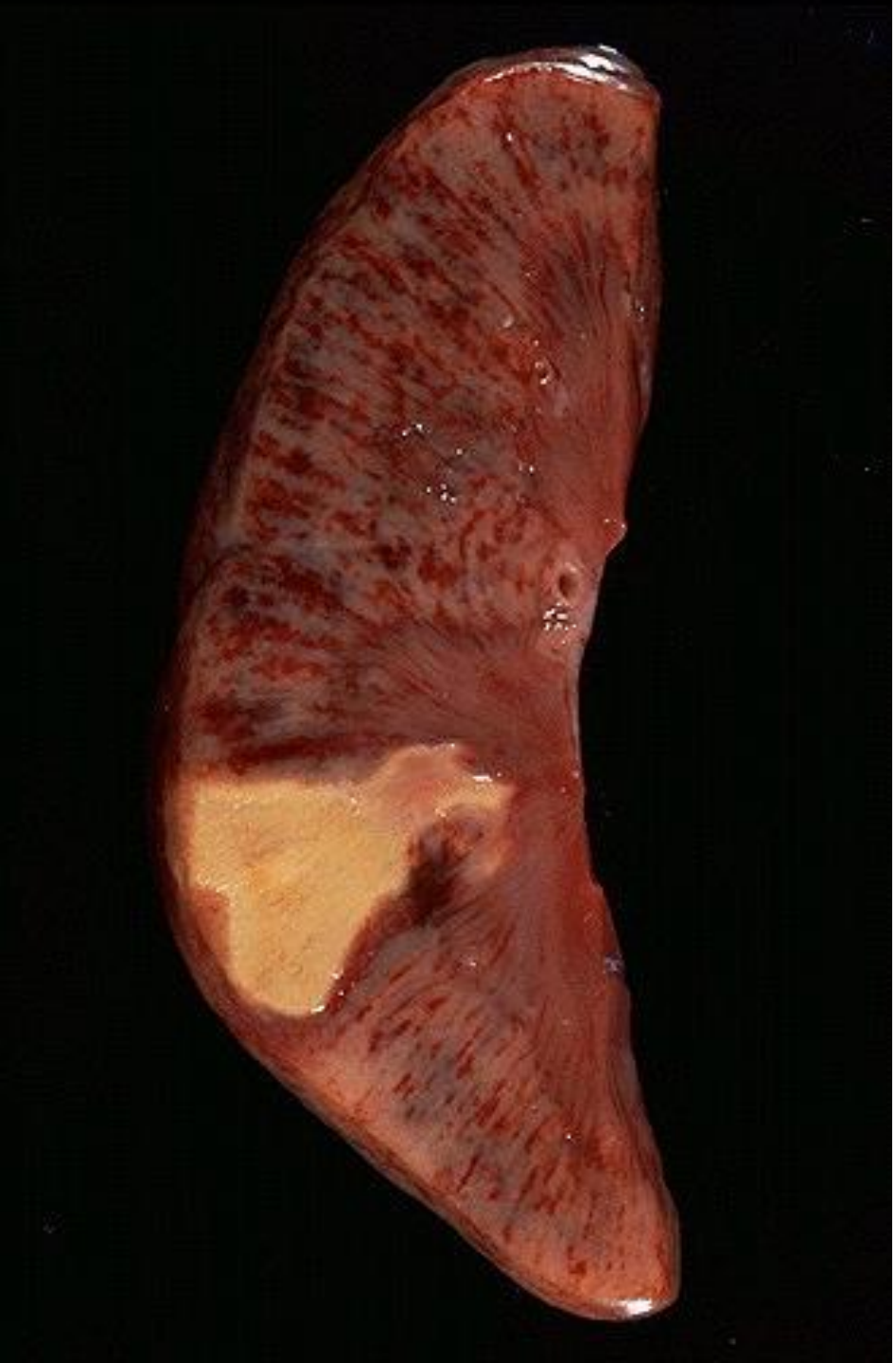


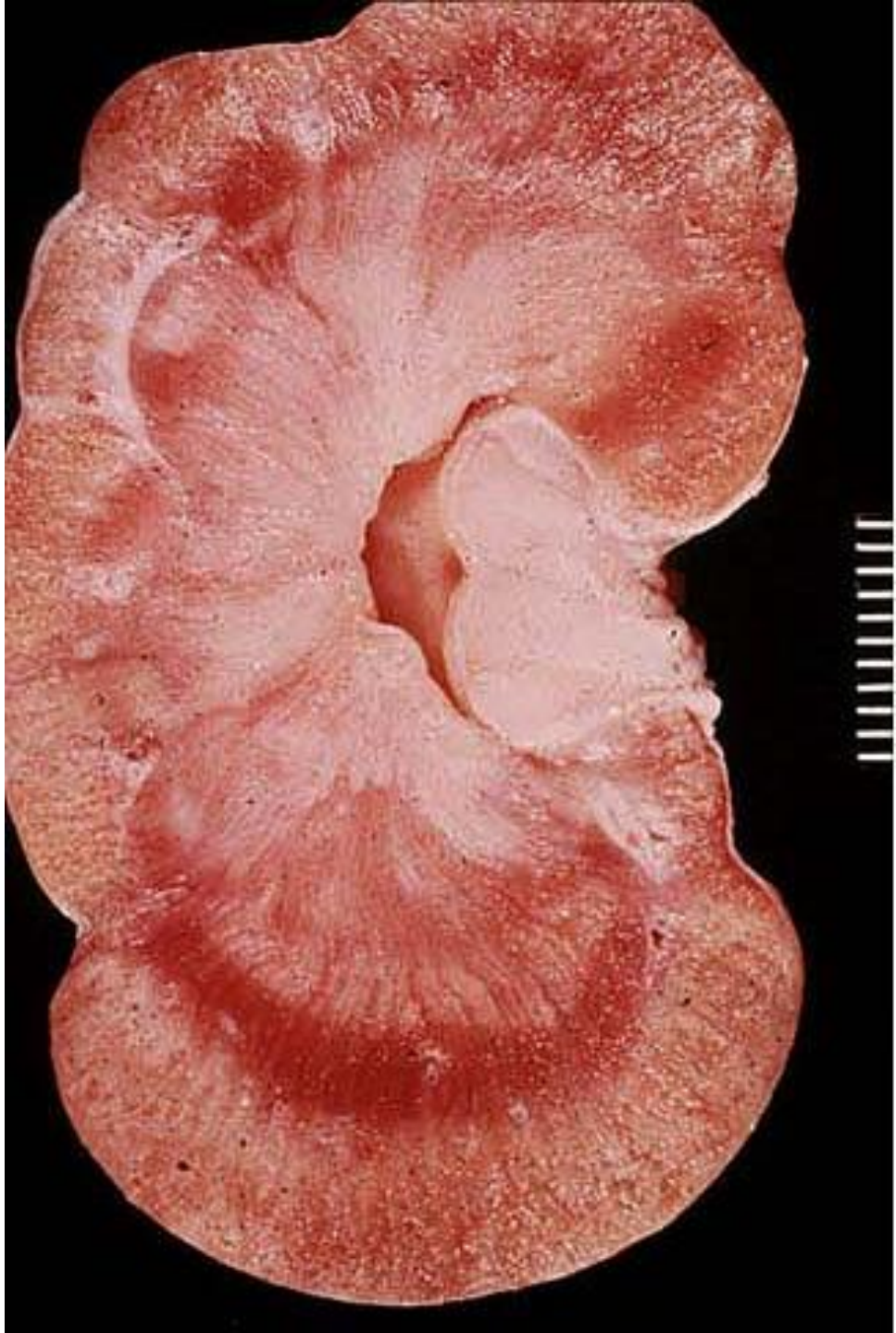


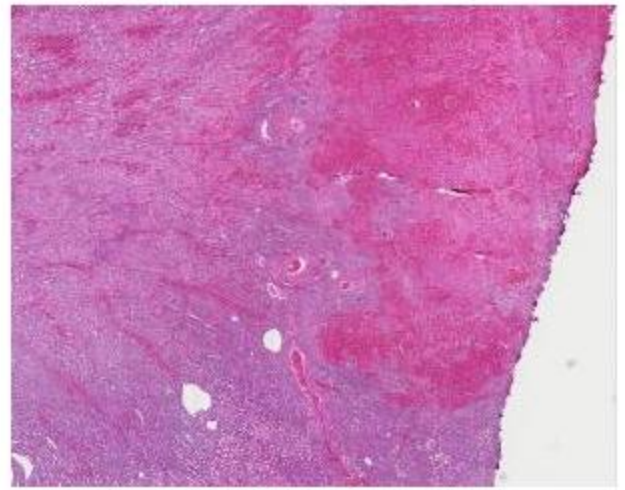


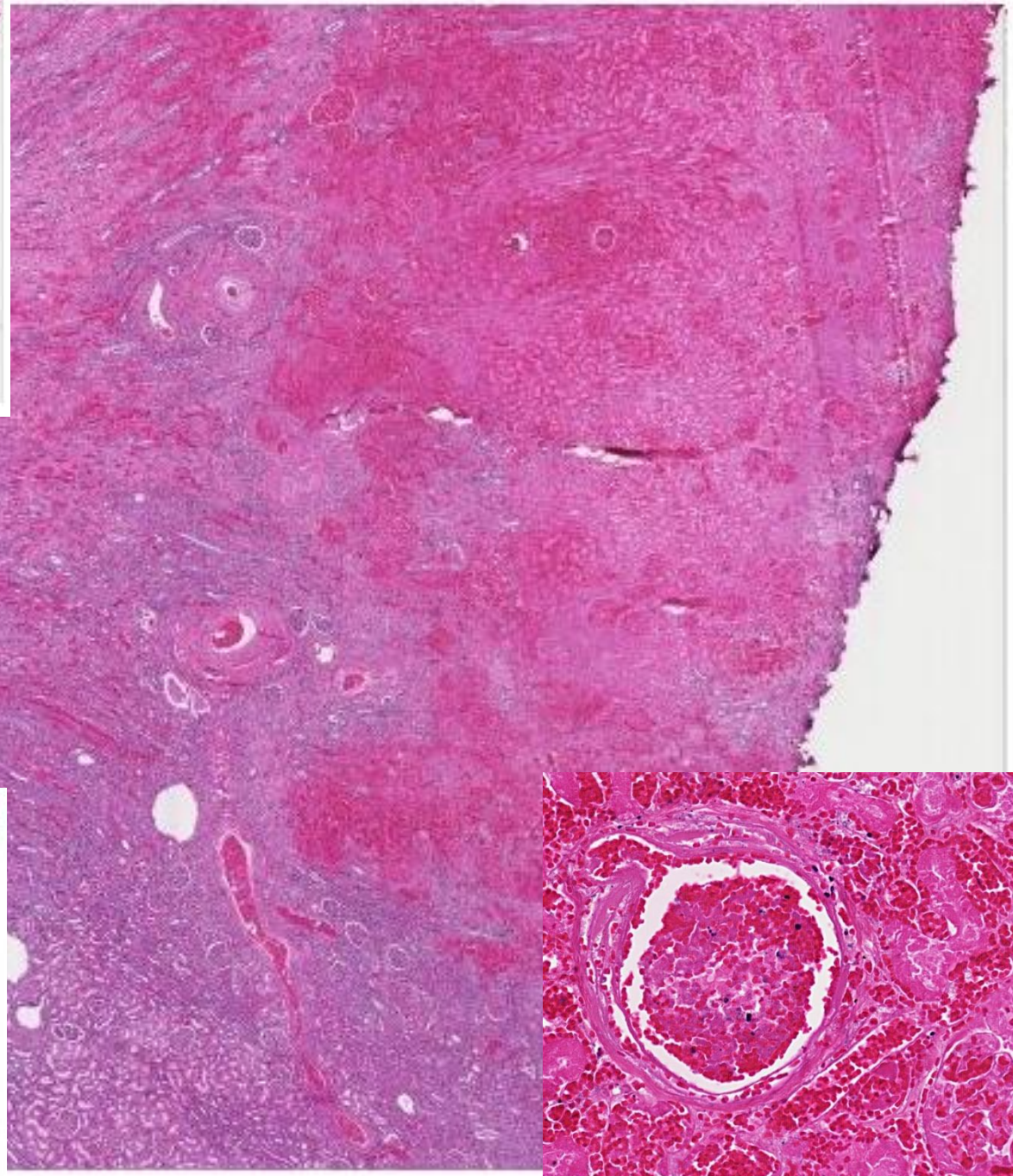
# RENAL INFARCTS

- WEDGE SHAPED
- WELL DELINEATED
- “WHITE” (anemic) INFARCT
- Perhaps a little “YELLOW”
- HEAL WITH A SCAR









# OBSTRUCTIONS

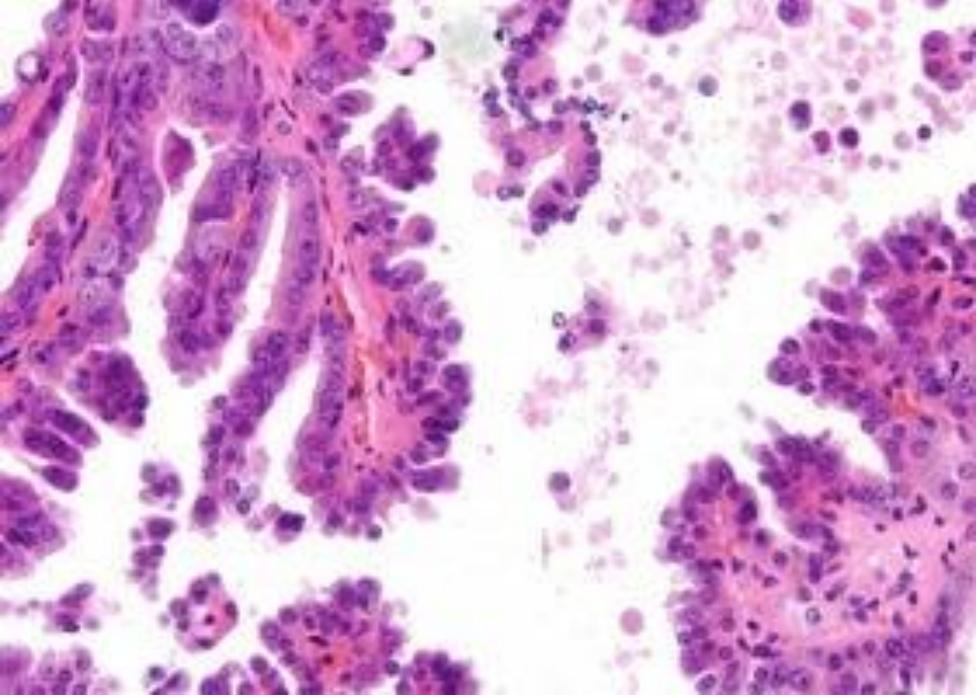
- **UROLITHIASIS**
- CONGENITAL
- PROSTATE ENLARGEMENT
- TUMORS
- INFLAMMATION
- SLOUGHED CLOTS, PAPILLAE
- PREGNANCY
- NEUROGENIC

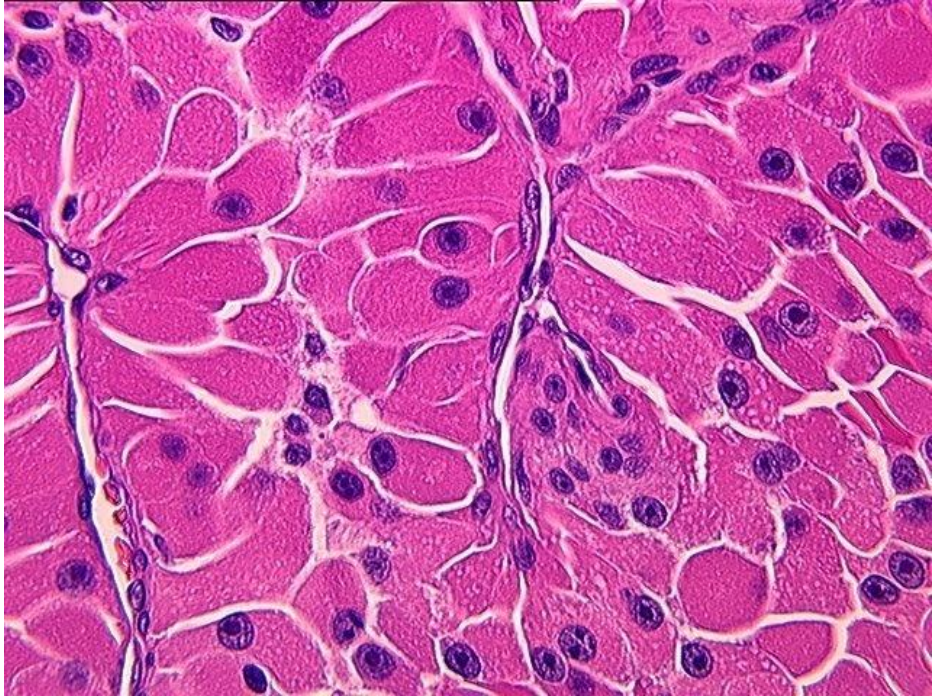
# UROLITHIASIS

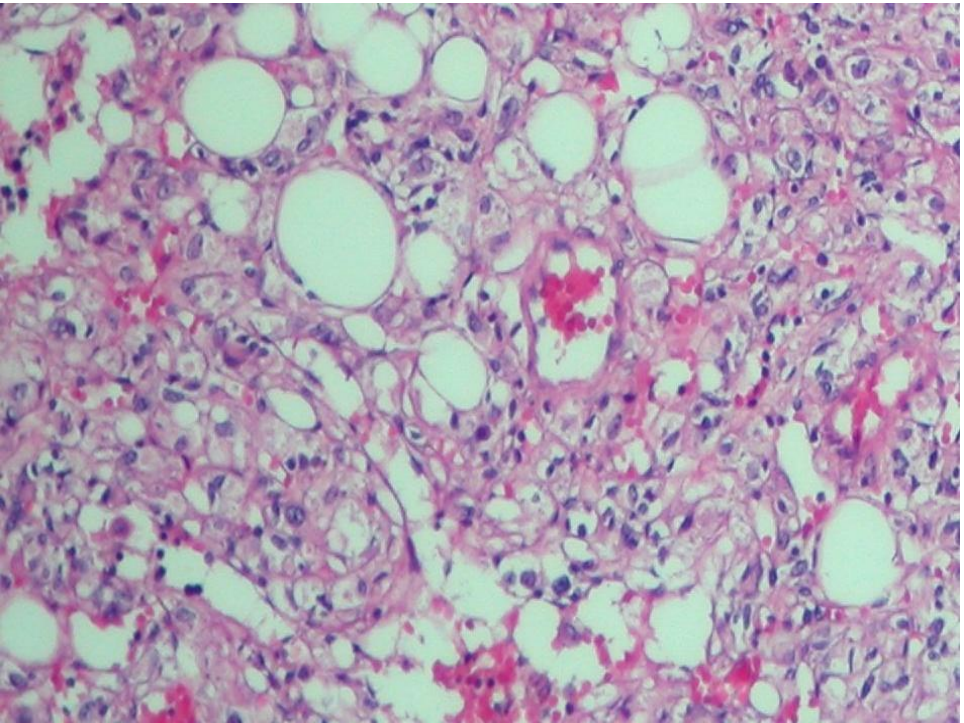
- **CALCIUM (OXALATE or PHOSPHATE) 70%** → CA↑↑↑
- **MAGNESIUM AMMONIUM PHOSPHATE 20%** → Bact.
- **URIC ACID 10%** → U.A. ↑↑↑

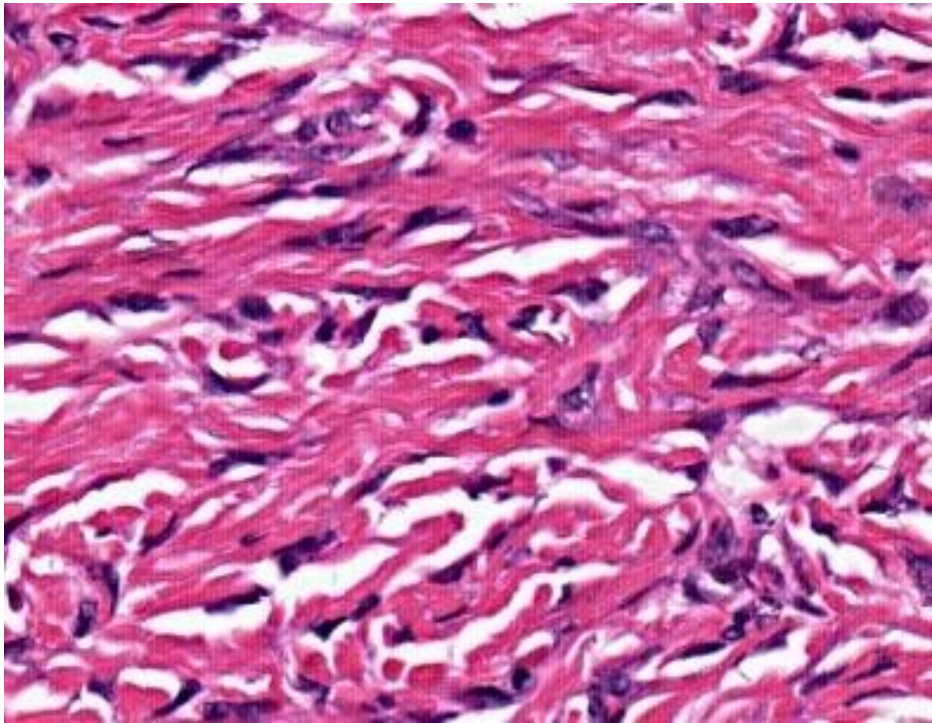
# TUMORS

- **BENIGN**
  - Papillary Adenoma
  - Fibroma/Hamartoma
  - Angiomyolipoma
  - Oncocytoma
- **MALIGNANT**
  - Renal Cell Carcinoma (Clear Cell Carcinoma, Adenocarcinoma, Hypernephroma)
  - Urothelial (Transitional)



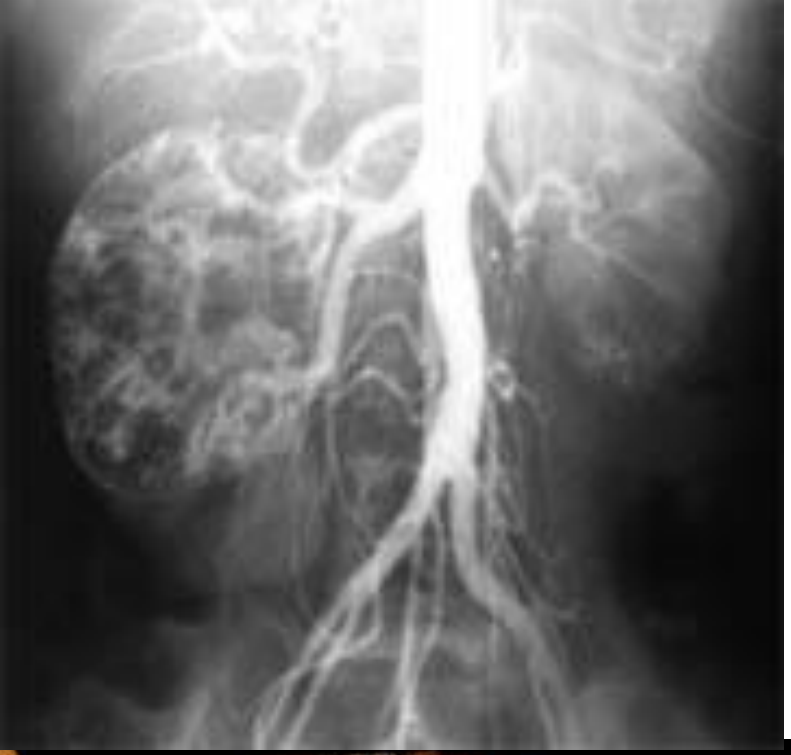


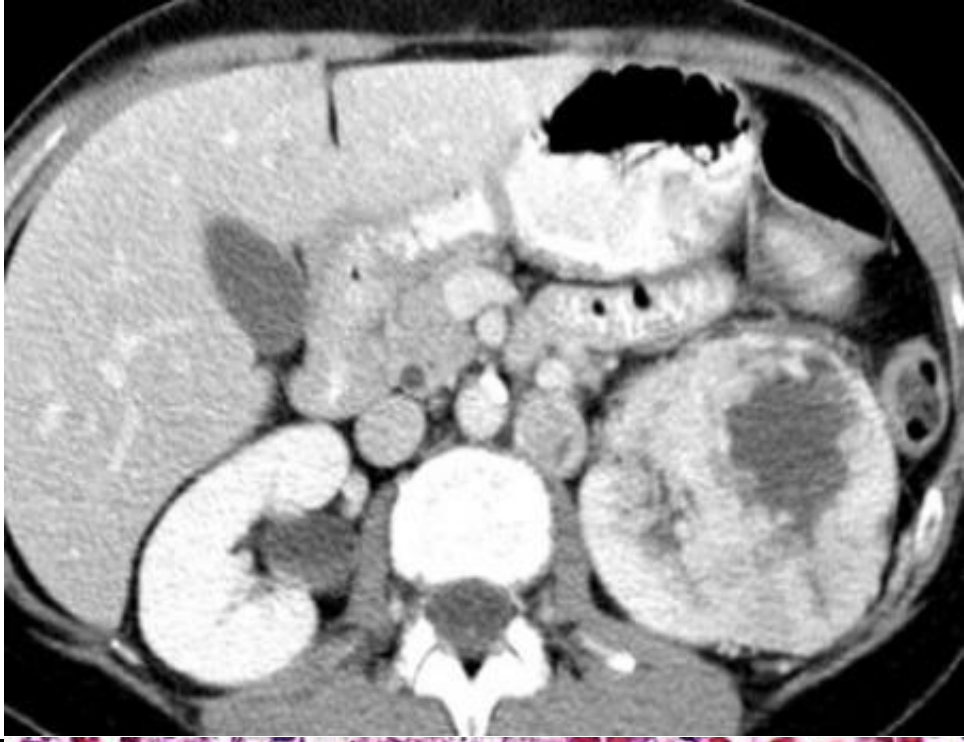


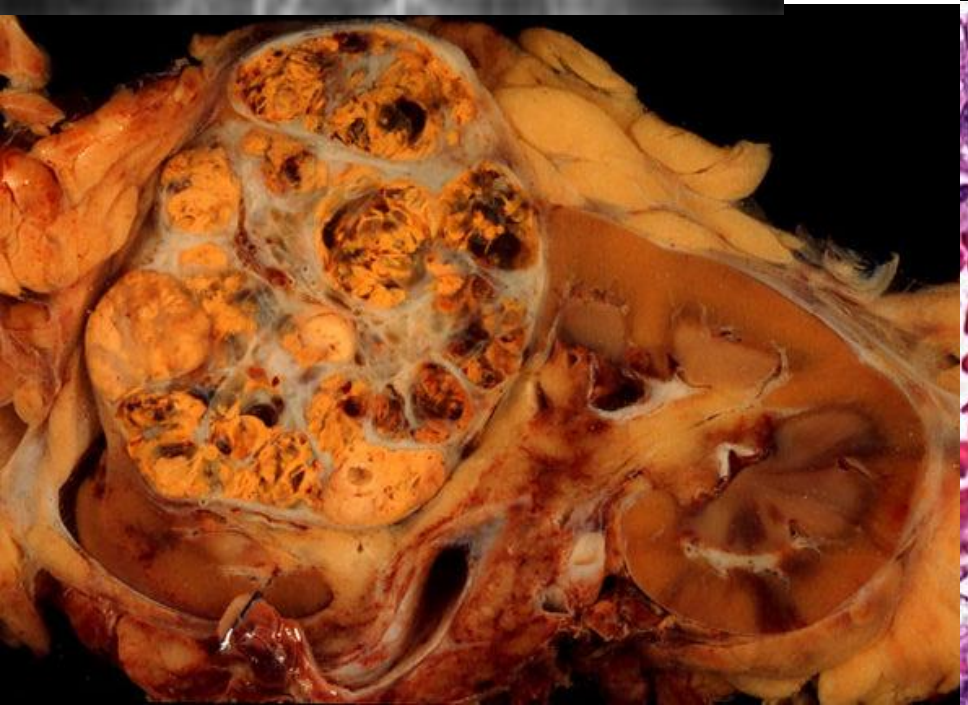


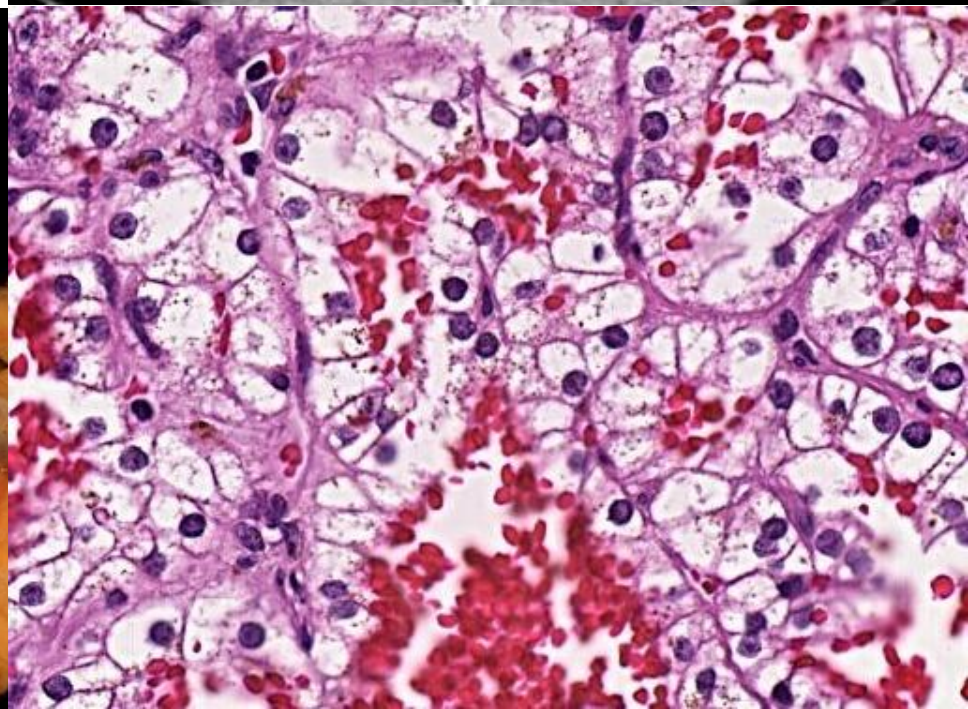
# RENAL CELL CARCINOMA

- TOBACCO RELATED, STRONGLY
- SOME HEREDITARY/FAMILIAL
- MOST are "CLEAR CELL", a few PAPILLARY
- YELLOW grossly, "CLEAR" cells microscopically
- STRONGLY tend to invade the renal VEIN early, in preference to lymphatics. Does the kidney have lymphatics?









# UROTHELIAL (TRANSITIONAL) RENAL CARCINOMAS

- In renal pelvis. Why?
- 1/10 as common as renal cell carcinomas
- EXACTLY the same appearance as lower urinary tract carcinomas. Why?
- MUCH more likely to obstruct the kidney than renal cell carcinomas. Why?
- Associated with ureter and bladder carcinomas. Why?