Kidney Organization and Disease

Introduction to Pathology of Disease Course
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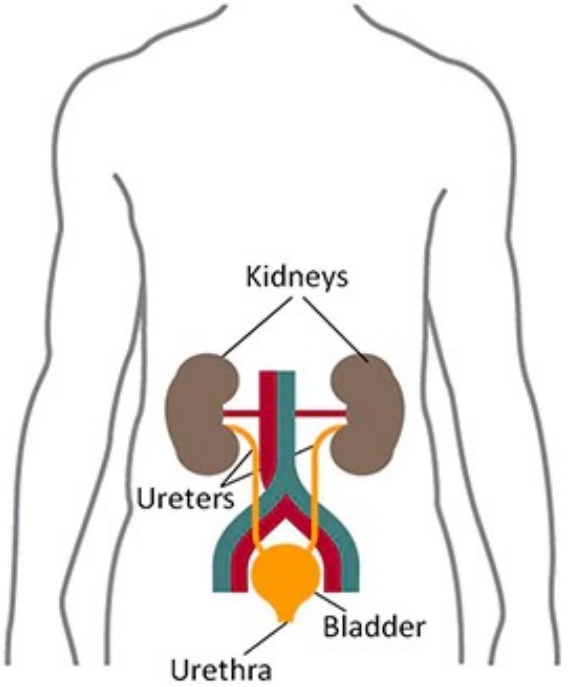
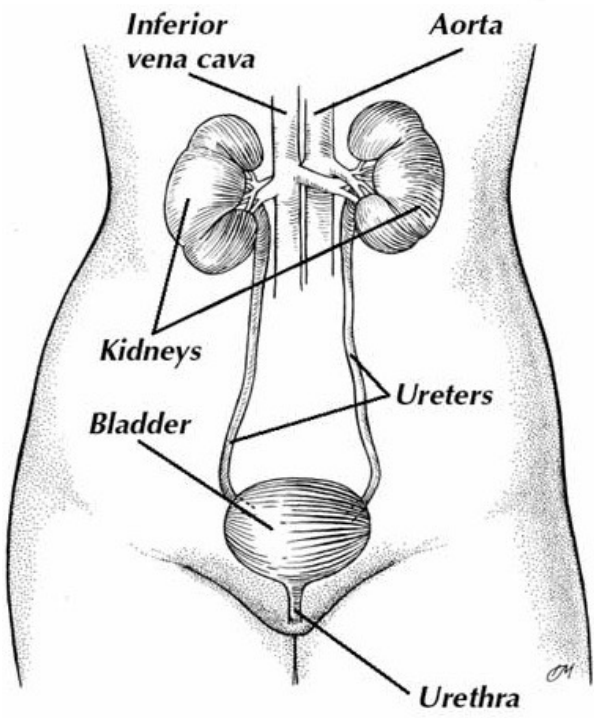
The Kidneys

- **Morphology:** Two bean-shaped organs
- **Location:** Below the rib cage, one on each side of your spine.
- **Function:**
  - Reabsorb electrolytes and water
  - Filter extra water and wastes out of your blood
  - Makes urine
- Urine flows from the kidneys to the bladder through two thin tubes called ureters
- Your bladder stores urine

Urinary Tract System



Urinary Tract System

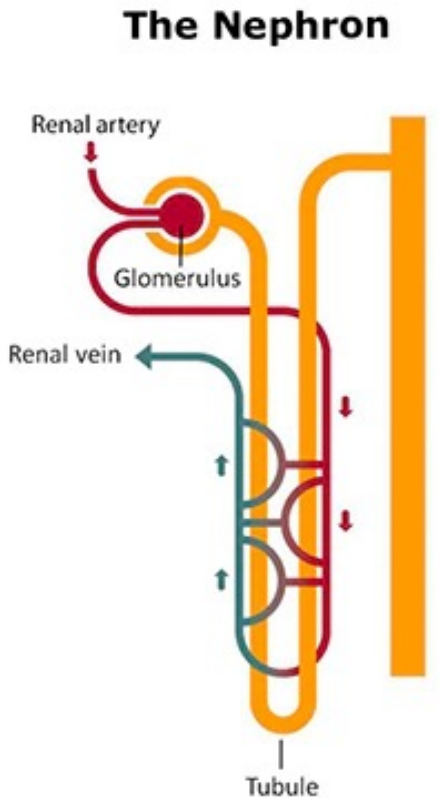


Why are the kidneys important?

- Kidneys remove waste and extra fluid from your body
- Remove acid that is produced by the cells of your body
- Maintain a healthy balance of water, salts, and minerals in your blood (sodium, calcium, potassium)
- Kidneys make hormones that help control blood pressure and maintain bone integrity

The Function of the Kidney

- Each kidney is made up of a million filtering units called **nephrons**
- Nephrons consist of the:
  - Glomerulus
  - Tubules (Proximal and Distal tubules)
- Two step process:
  - Glomerulus filters your blood
  - Tubules return needed substances to your blood and removes waste (e.g. toxins, urea and creatinine)

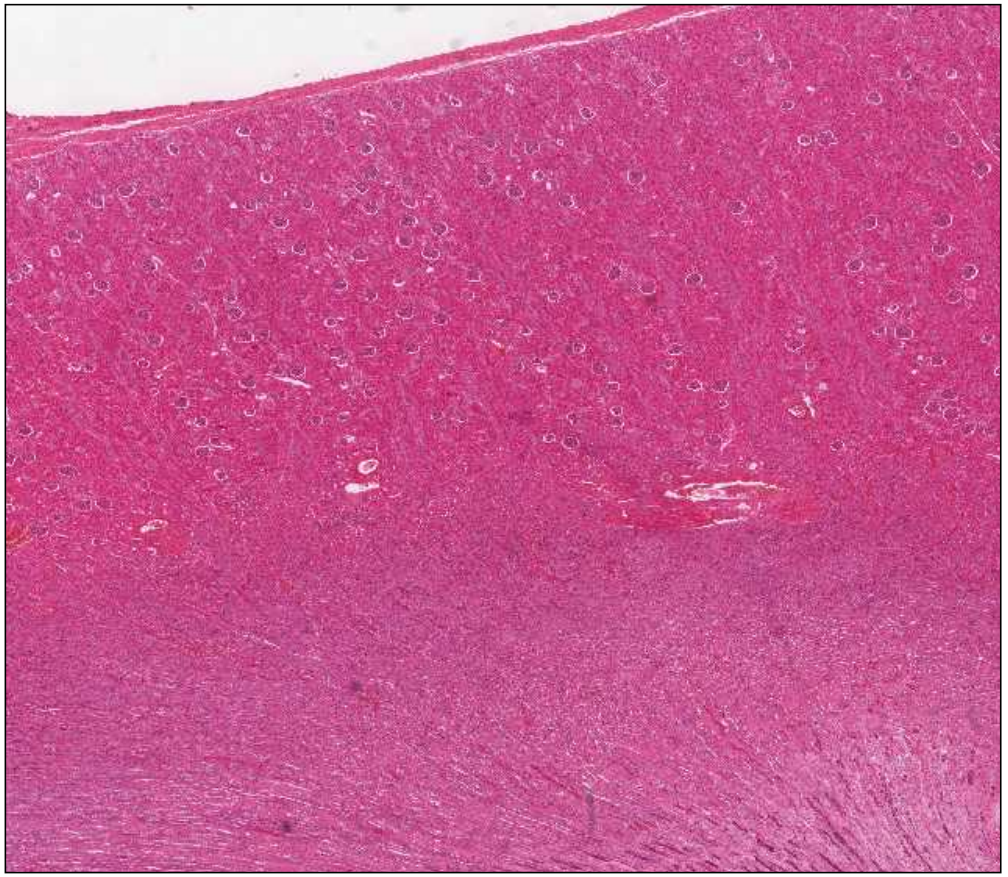


Gross Anatomy of the Kidney

(Webpath)

Kidney (low magnification)

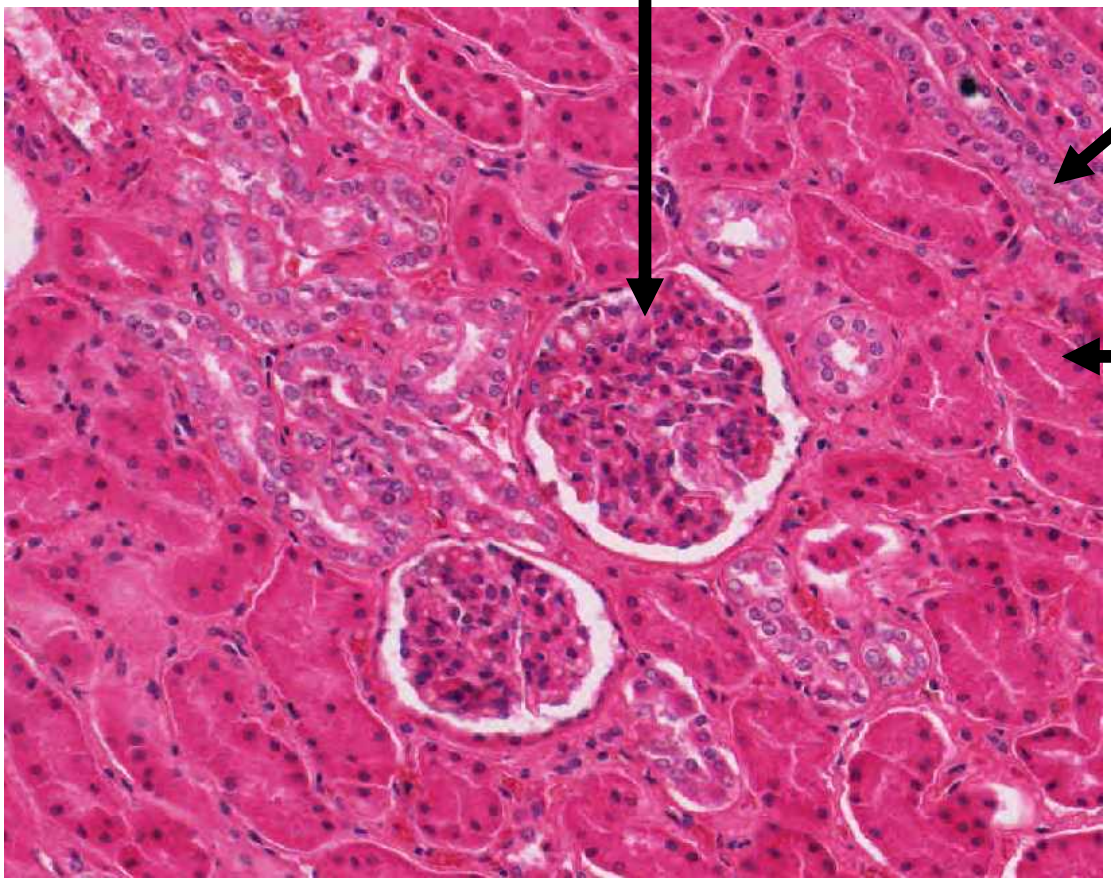
Cortex(with glomeruli)



Medulla

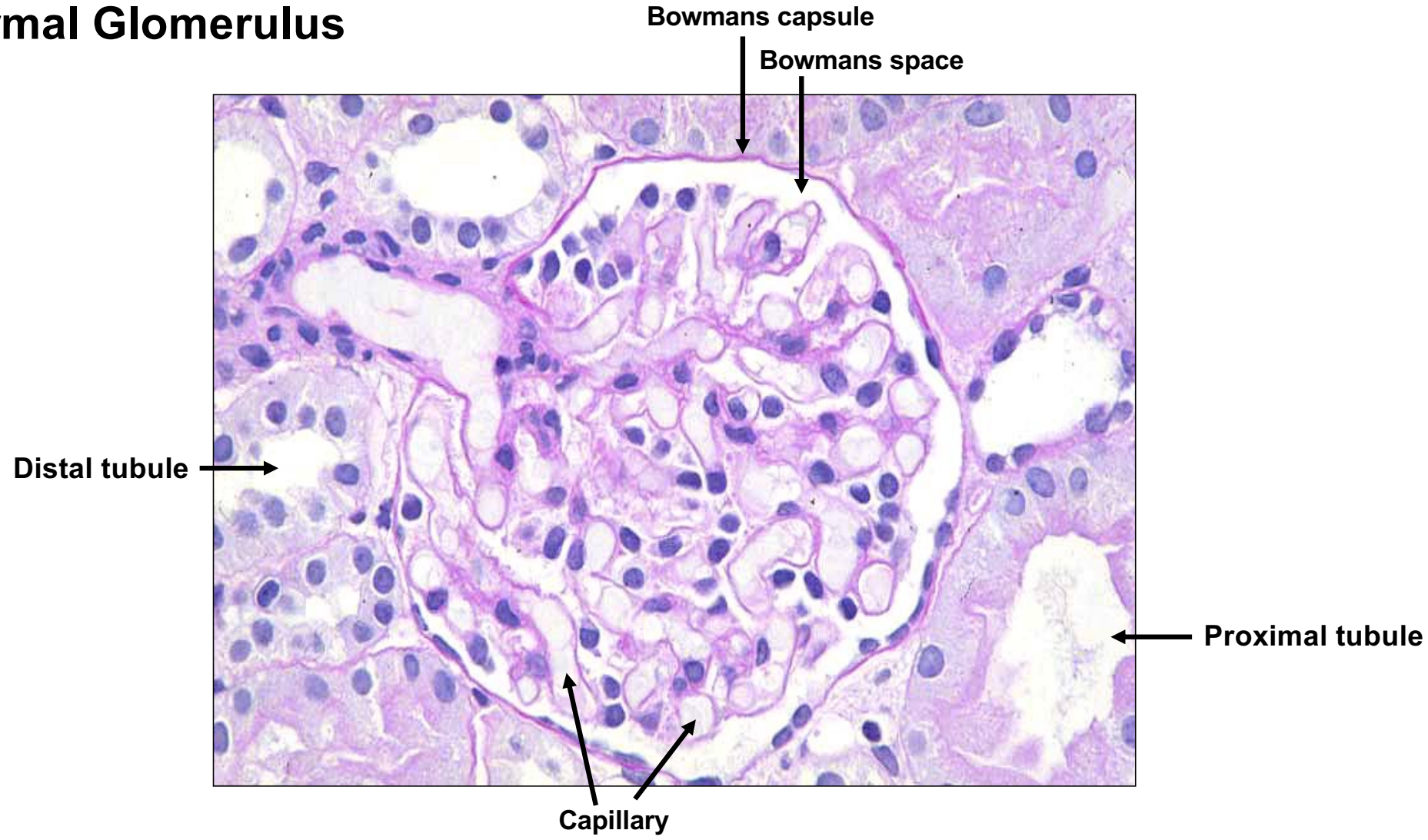
(VM-UNC)

Renal cortex



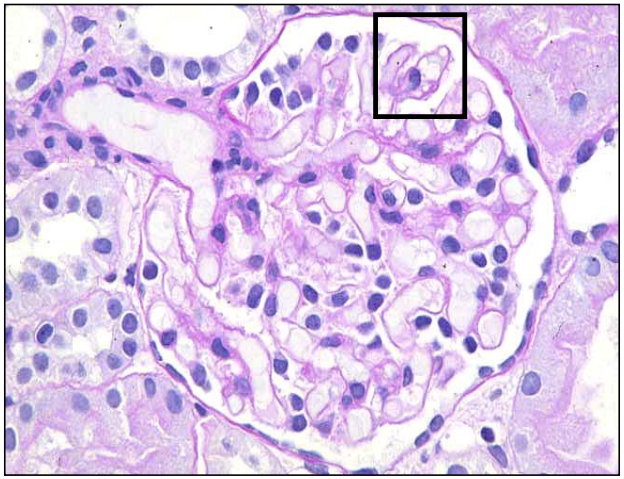
(VM-UNC)

Normal Glomerulus

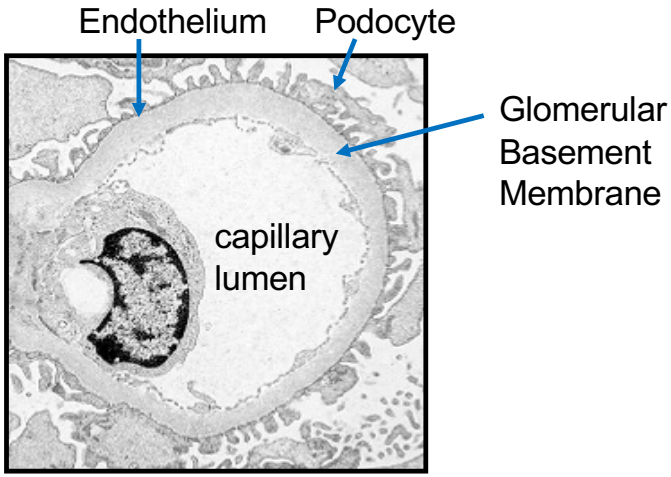


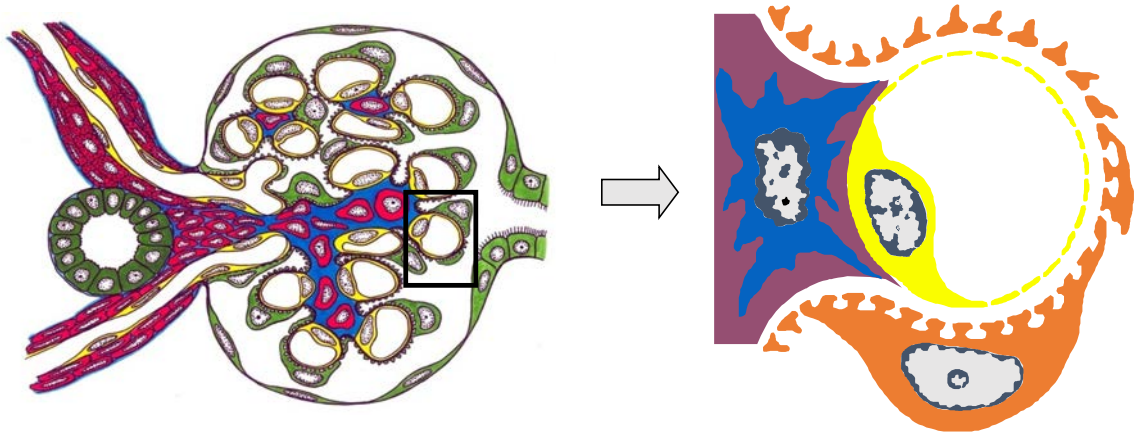
Normal Glomerular Capillary

Light Microscope



Electron Microscope

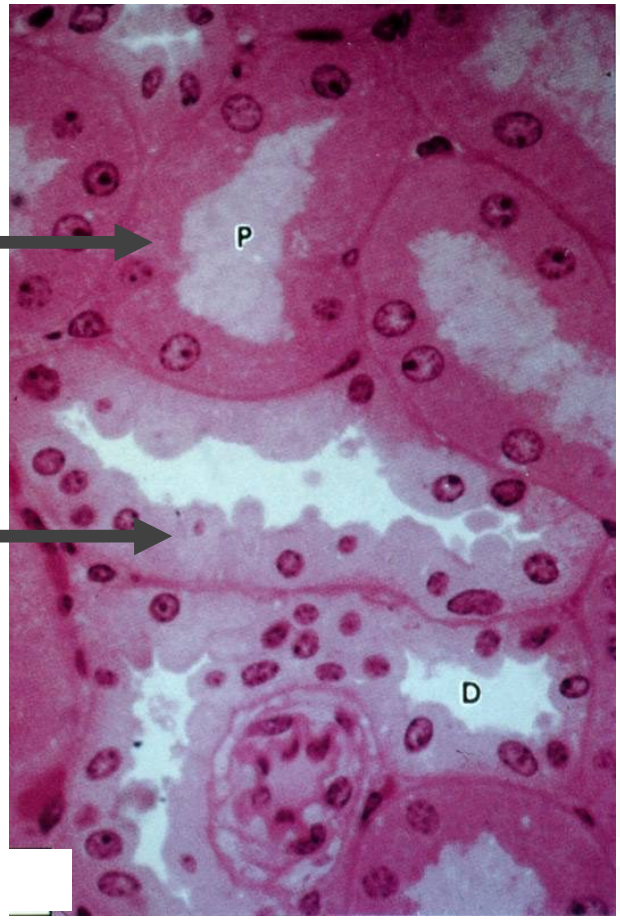




Renal cortex: Proximal and Distal Tubules

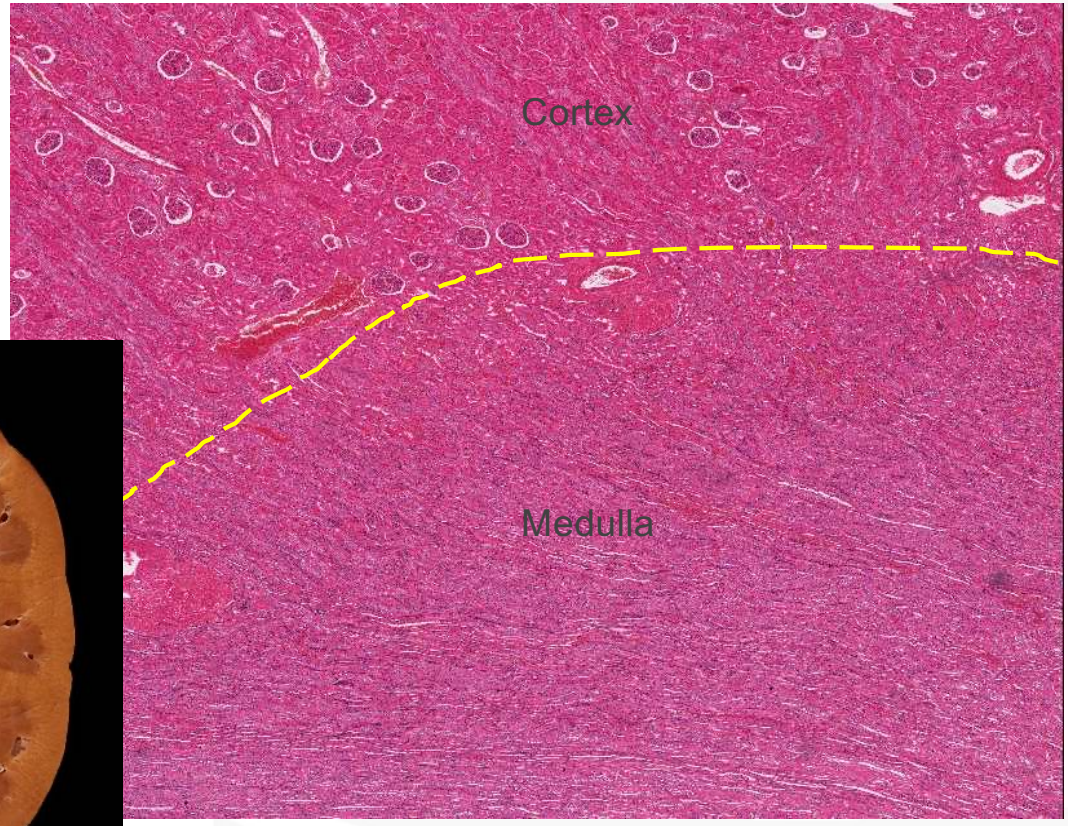
Proximal tubules

Distal tubules



(Kessel)

Renal corticomedullary junction



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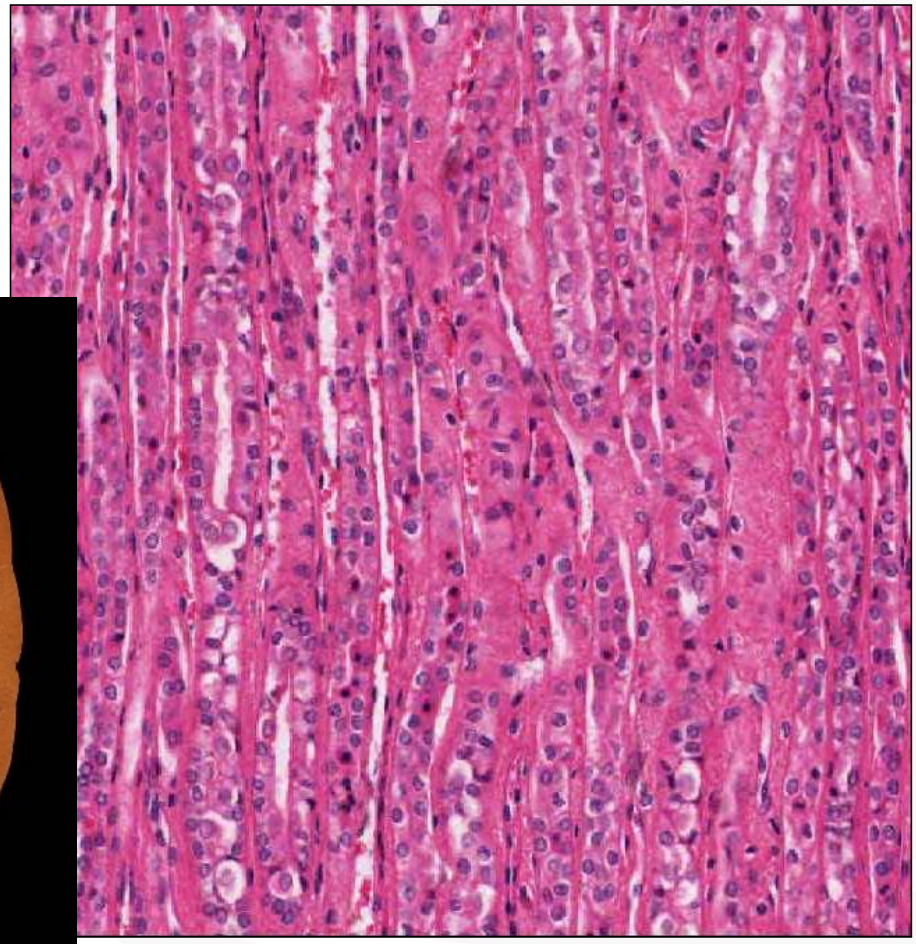
Renal Medulla



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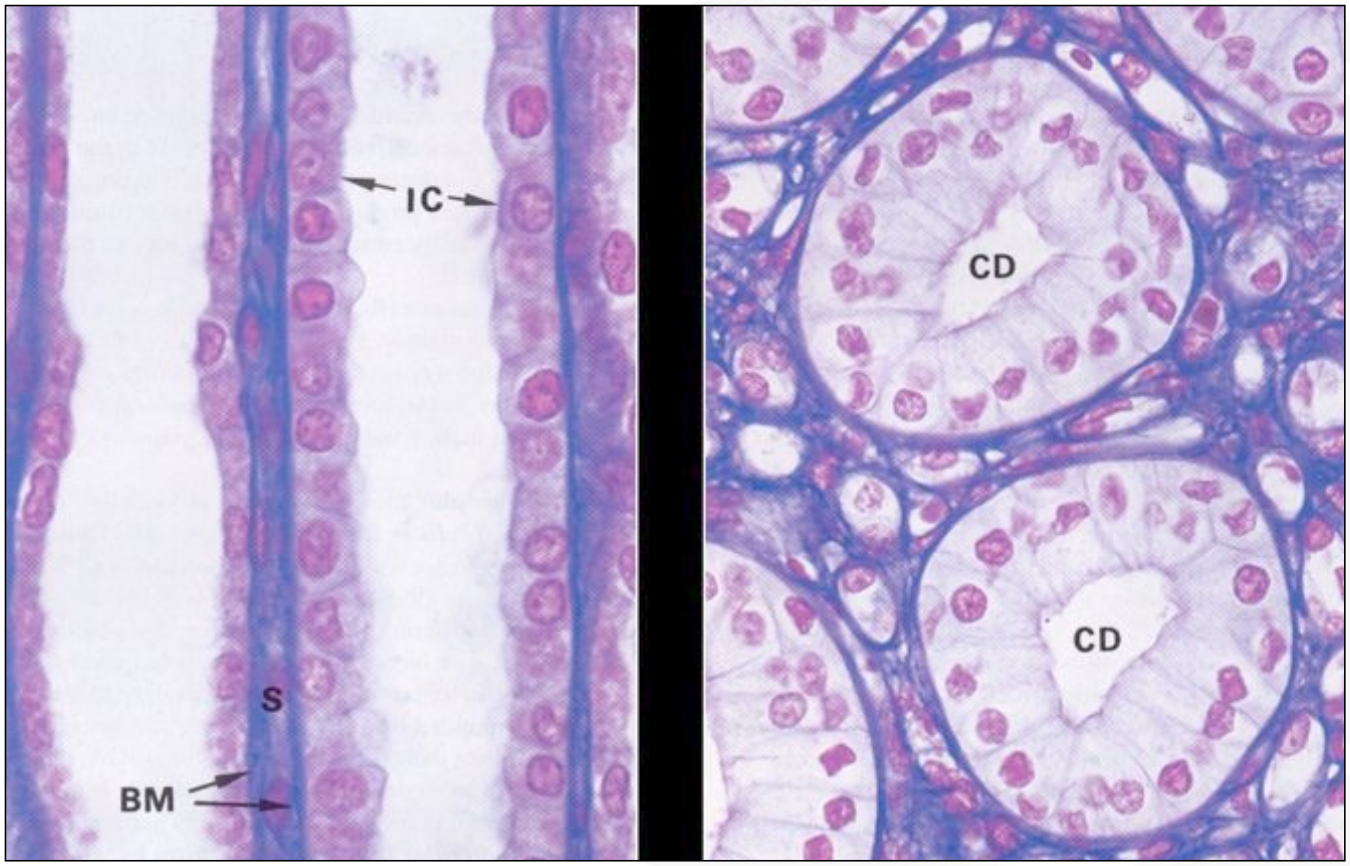
Collecting Ducts



(Wheater)

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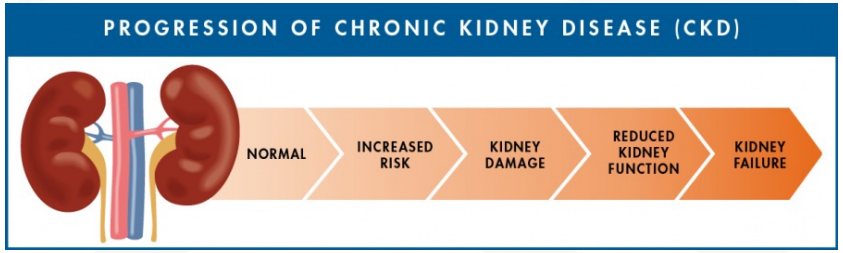
Chronic Kidney Disease

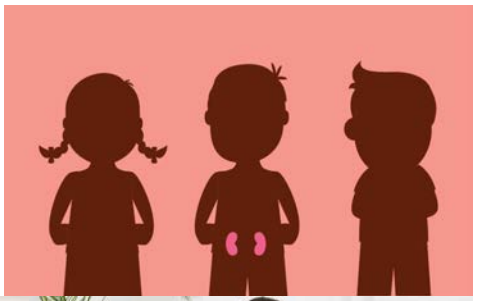
- "Chronic"- damage to the kidneys happen slowly over a long period of time
- More than 37 million American adults may have CKD
- Leading cause of CKD is diabetes. Almost 1 in 3 people with diabetes has CKD
- Waste build up in your body
- *APOL1* gene variant is associated end stage kidney disease in young adults of African descent
- Treatment: Dialysis or kidney transplant to maintain disease progression



Kidney diseases in children

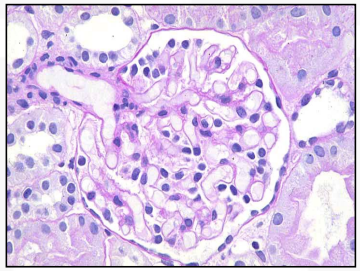
- From birth to age 4, birth defects and hereditary diseases are the leading cause of kidney failure.

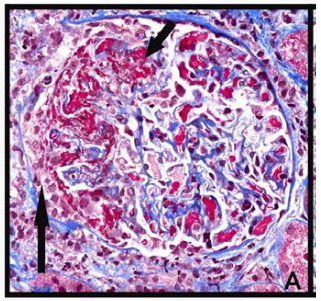
- Other causes of kidney diseases:
  - Birth defects
  - Hereditary diseases
  - Infection
  - Systemic diseases (lupus nephritis, diabetes)
  - Trauma



Glomerular diseases

- Damage to the glomeruli causes protein and sometimes red blood cells to leak into the urine
- Interferes with the clearance of waste products by the kidney
- Proteins and fluid can build up in the blood
- Fluid can accumulate outside the circulatory system in the face, hands, feet, or ankles and cause swelling
- Examples for glomerular diseases:
  - Systemic lupus erythematous
  - HIV
  - Diabetic nephropathy
  - ANCA vasculitis





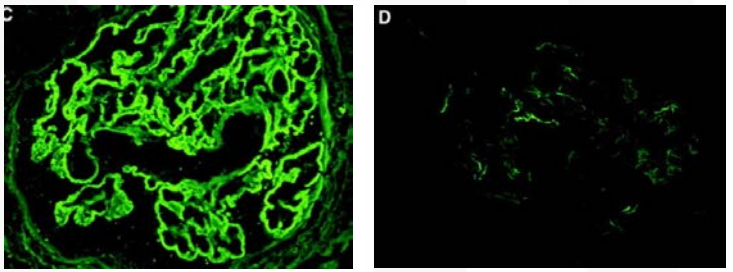
A large range of symptoms for kidney diseases

- Nausea
- Vomiting
- Loss of appetite
- Fatigue and weakness
- Sleep problems
- Urinating more or less
- Decreased mental sharpness
- Muscle cramps
- Swelling of feet and ankles
- Dry, itchy skin
- High blood pressure (hypertension) that's difficult to control
- Shortness of breath, if fluid builds up in the lungs
- Chest pain, if fluid builds up around the lining of the heart

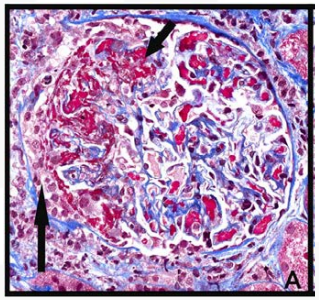
Kidney Disease Diagnosis

- Blood tests, checks how well your kidneys are filtering your blood called glomerular filtration rate (GFR)
- Urine tests, to check for kidney failure (e.g. levels of albumin)
- A kidney biopsy, to determine the cause of the kidney disease or type of kidney disease

Membranous Glomerulonephritis

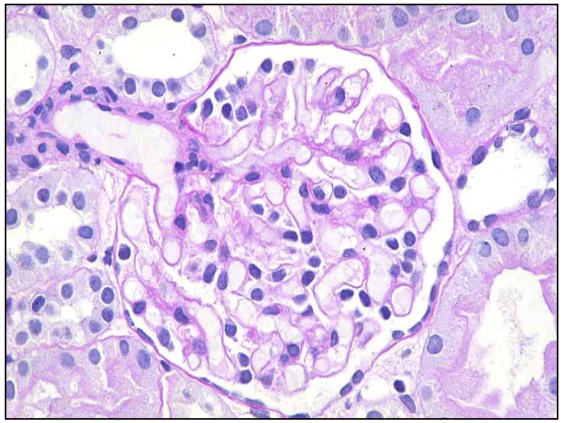


Crescentic Glomerulonephritis

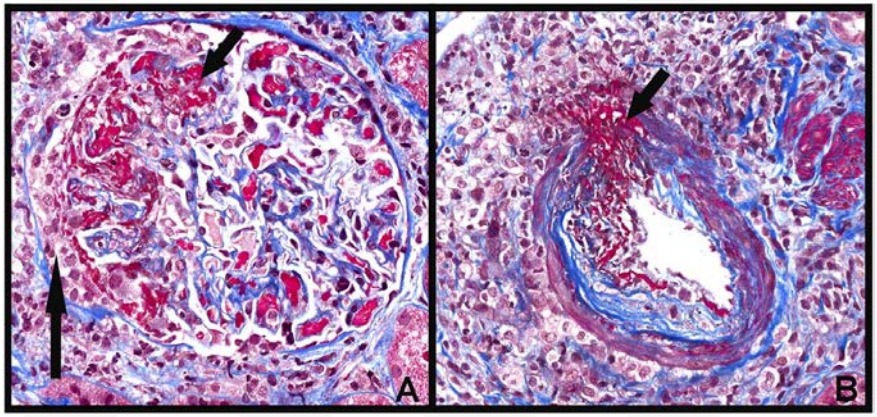


Normal vs. Abnormal Glomeruli

Normal



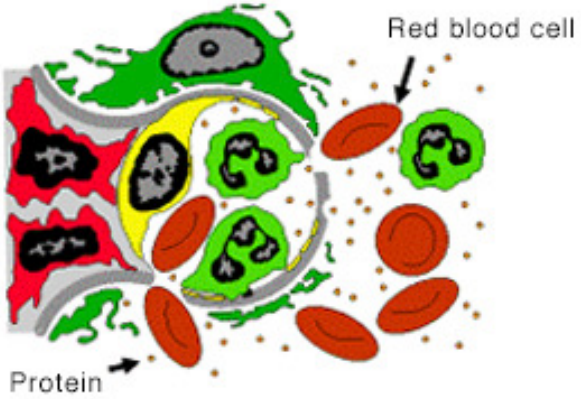
Abnormal
Crescentic Glomerulonephritis



Characteristics of Glomerulonephritis

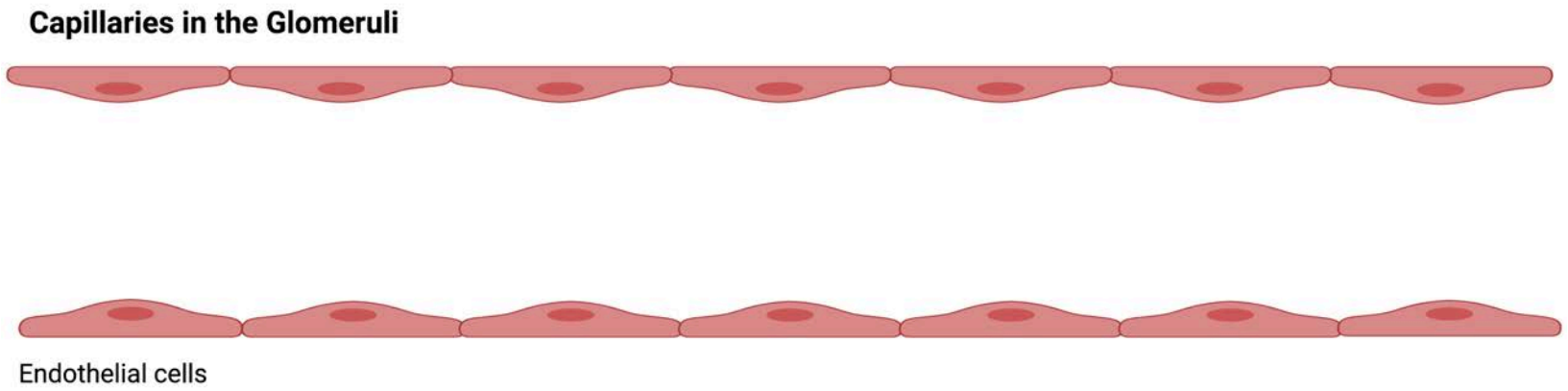
Proteinuria and Hematuria

A normal capillary in a glomerulus keeps red blood cells, white blood cells, and most proteins in the blood and only lets watery fluid into the urine.



A capillary in a diseased glomerulus lets protein into the urine (proteinuria) and red blood cells into the urine (hematuria).

General Mechanism of Glomerulonephritis



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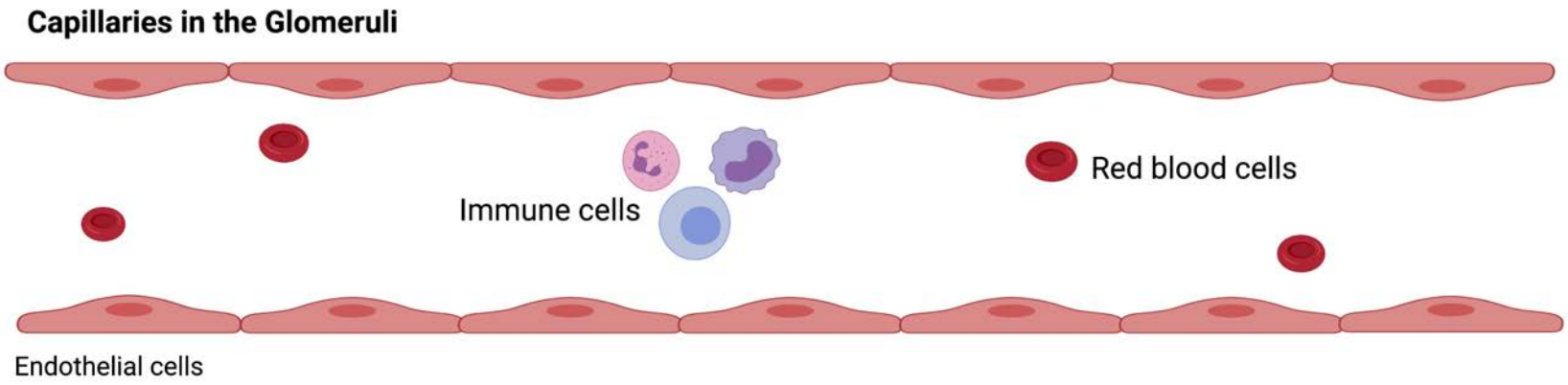

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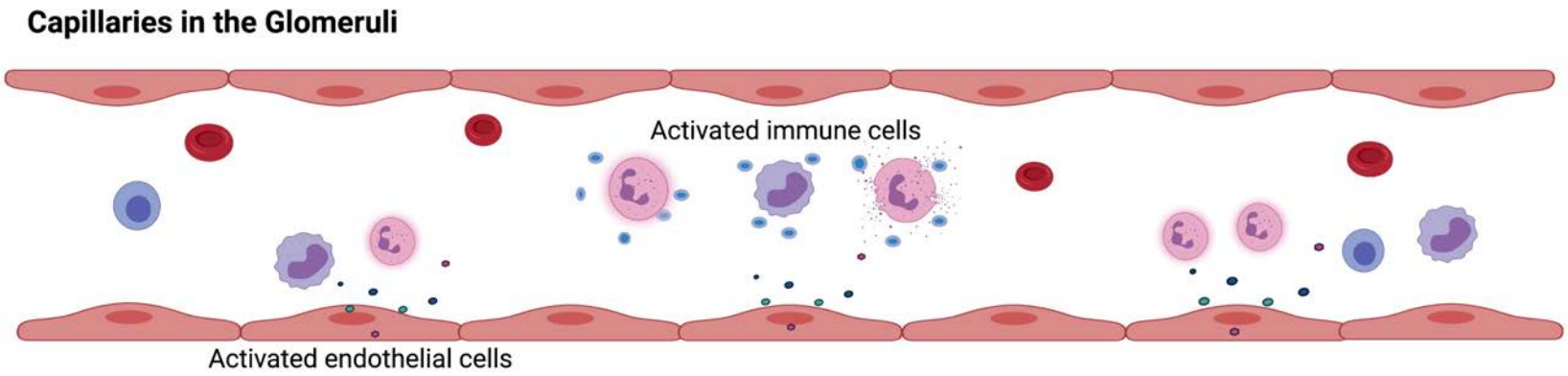

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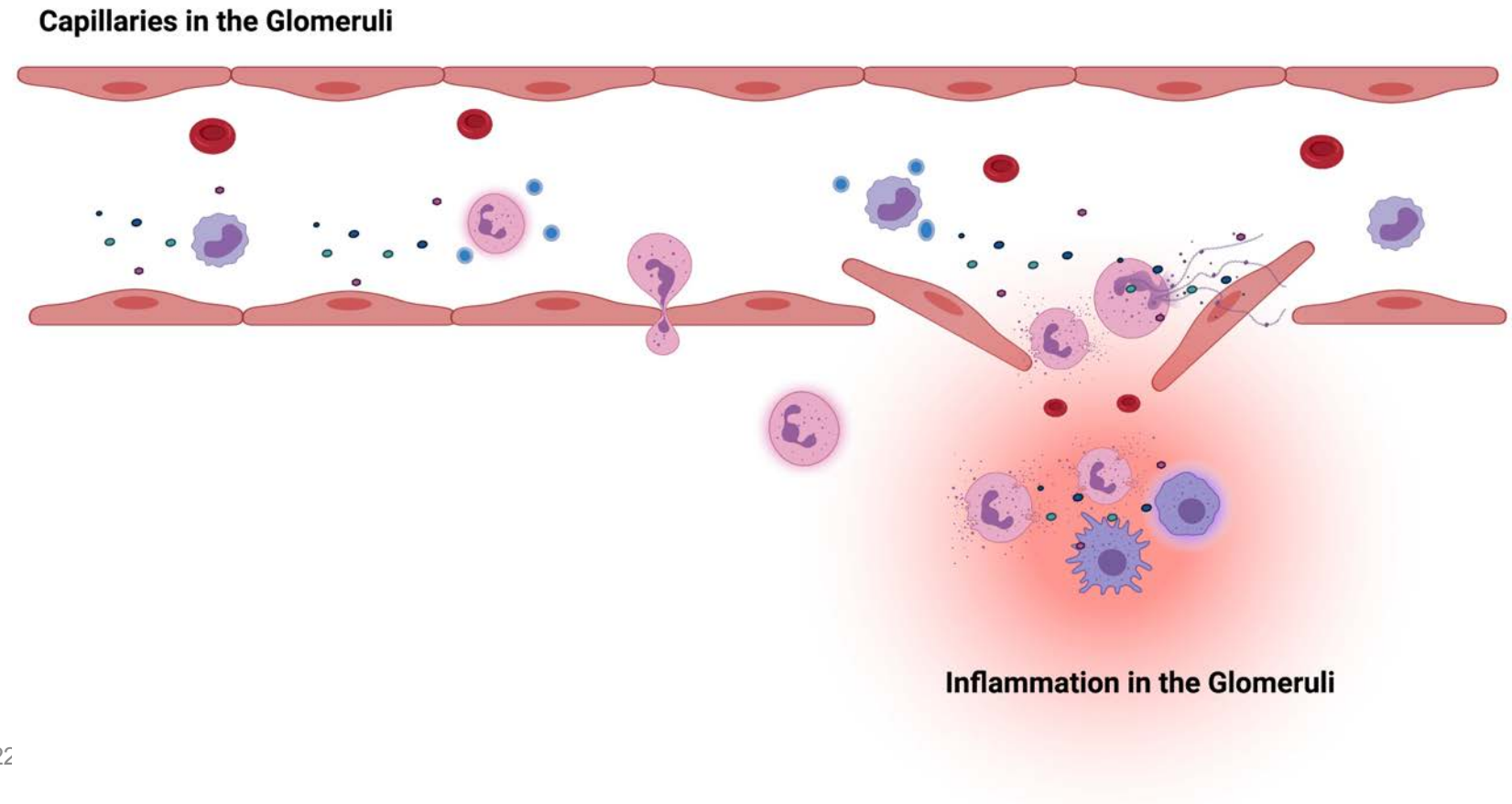

Summary Points

- Kidneys are responsible for removing waste and extra fluid from your body
- Each kidney is made up of 1) a million filtering units called nephrons in the cortex and 2) collecting ducts in the medulla
- A nephron consist of:
  - A glomerulus to filter the blood
  - Tubules to return needed substances to your blood and removes waste
- Few characteristics of glomerulonephritis are proteinuria and hematuria due to capillary damage
- During inflammation, activated endothelial and immune cells release proteins (e.g. cytokines) to recruit more immune cells to the kidney. The accumulation of activated immune cells in the kidney capillaries leads to vascular damage (vasculitis) and necrosis in the glomeruli.
- Damaged glomeruli can lead to the progression of kidney failure