Biochemistry of biological fluids (BIOCH 472)

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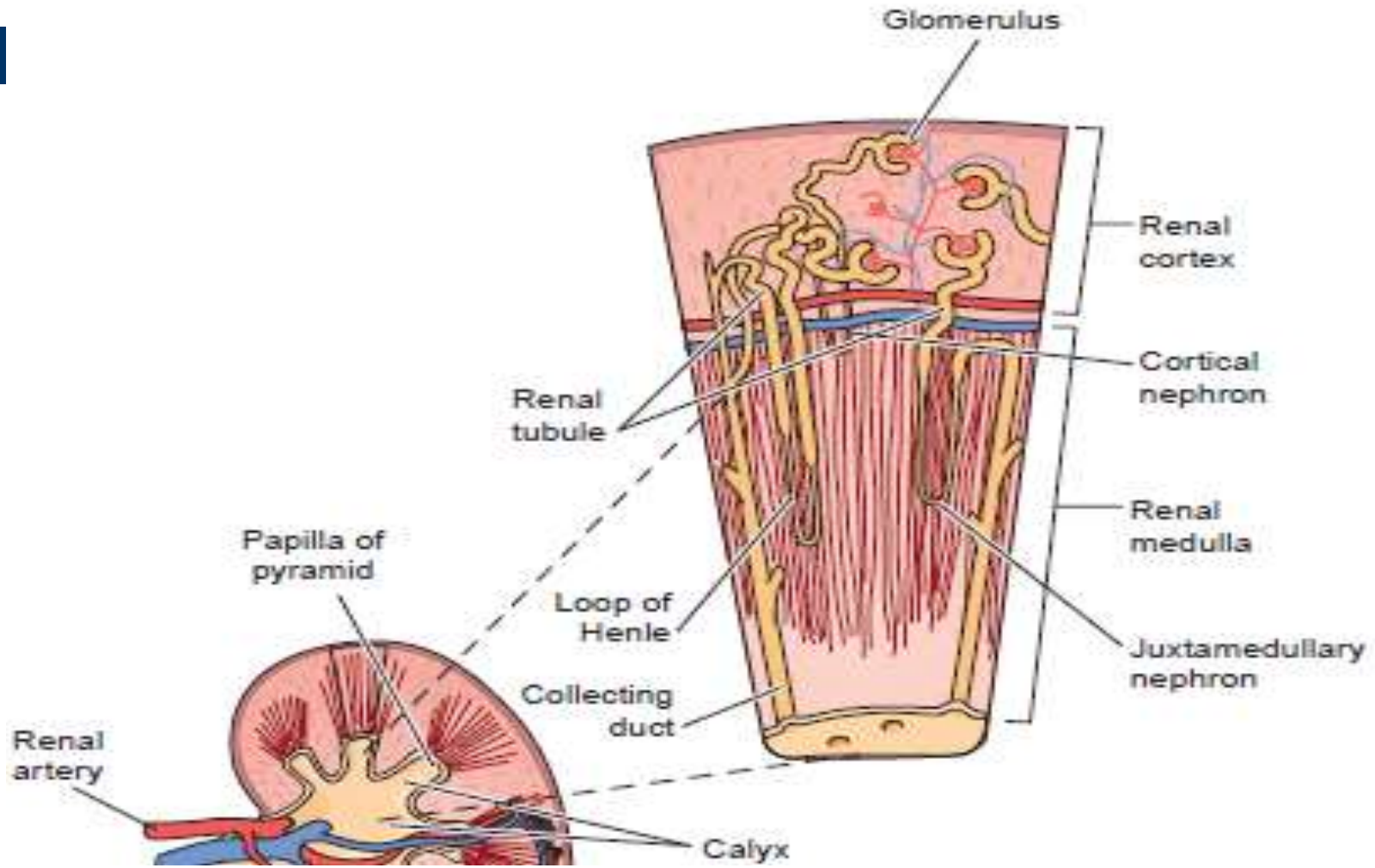
Class 4:

Urinalysis:
Renal Function

Objectives for this lecture

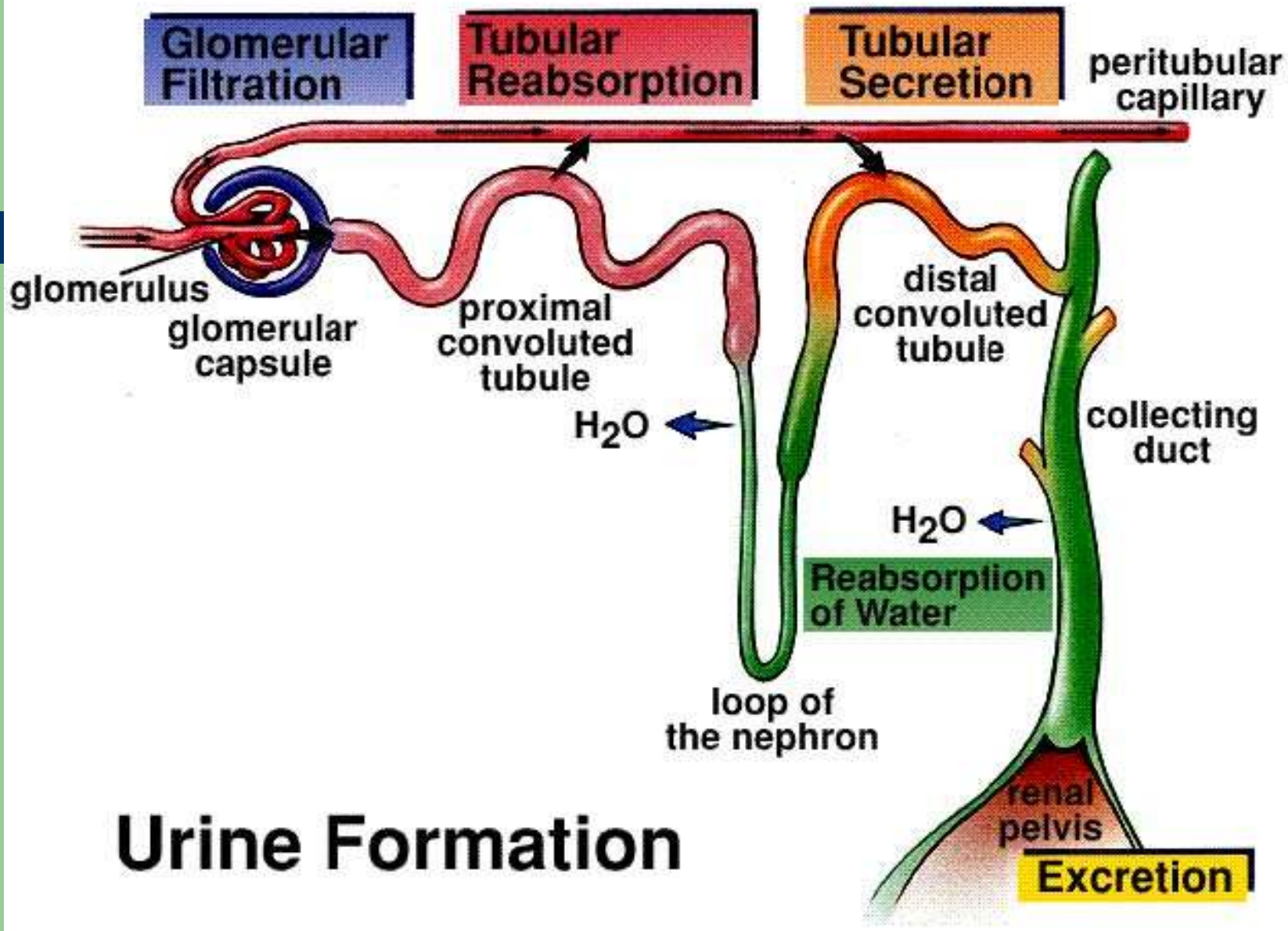
- Identify the components of the nephron, kidney, and excretory system.
- Describe the process of glomerular ultrafiltration.
- Identify the laboratory procedures used to evaluate glomerular filtration, tubular reabsorption and secretion, and renal blood flow.

Renal Physiology



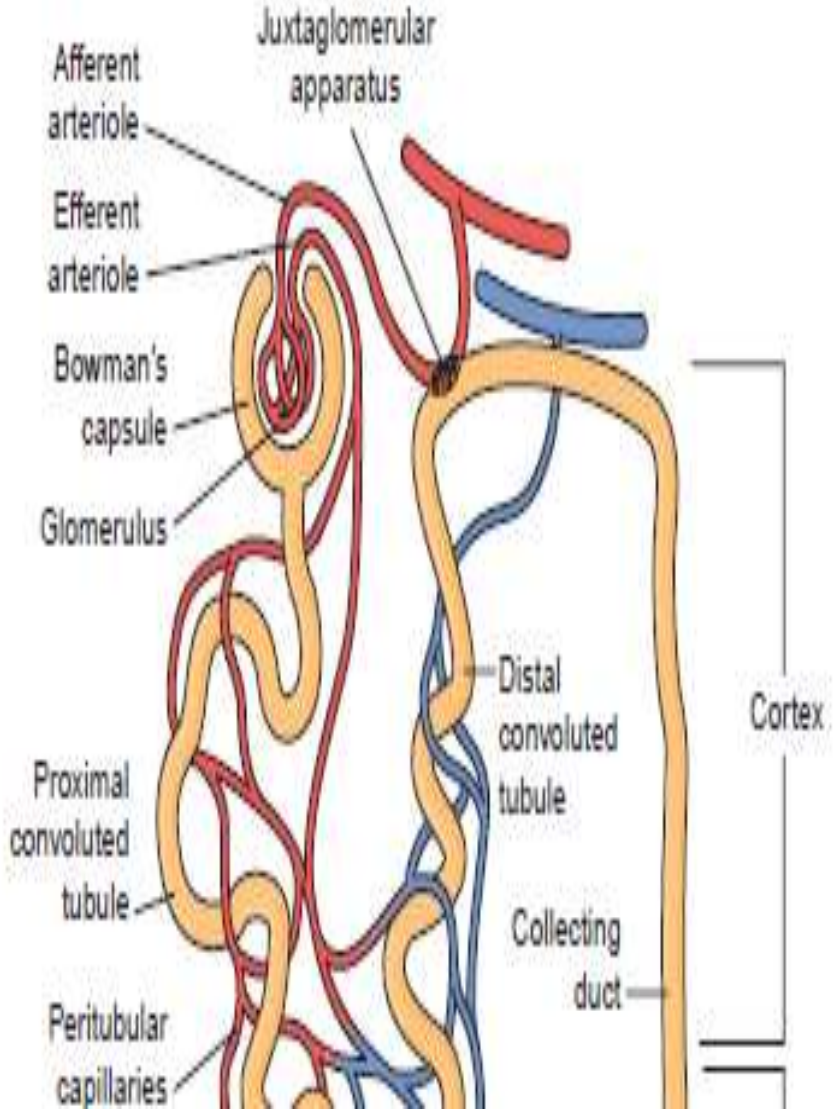
Nephrons

- Each kidney contains approximately 1 to 1.5 million.
- Cortical nephrons:
  - ✓ *arteriol, glomerulus, Bowman's capsule*
  - ✓ in the cortex of the kidney
  - ✓ responsible for removal of waste and reabsorption of nutrients.
- Juxtamedullary nephrons:
  - ✓ deep in kidney medulla
  - ✓ responsible for concentration of the urine.


Glomerular Filtration
Tubular Reabsorption
Tubular Secretion
peritubular capillary
glomerulus
glomerular capsule
proximal convoluted tubule
distal convoluted tubule
collecting duct
H_2O
H_2O
Reabsorption of Water
loop of the nephron
renal pelvis
Excretion
Urine Formation

Glomerular Filtration

- ***Glomerulus*:**
  - ✓ within Bowman's capsule (beginning of renal tubule)
  - ✓ Non-selective filter of plasma substances.
  - ✓ Do not allow the passage of large molecules and blood cells.
  - ✓ Hydrostatic pressure in it enhances filtration.



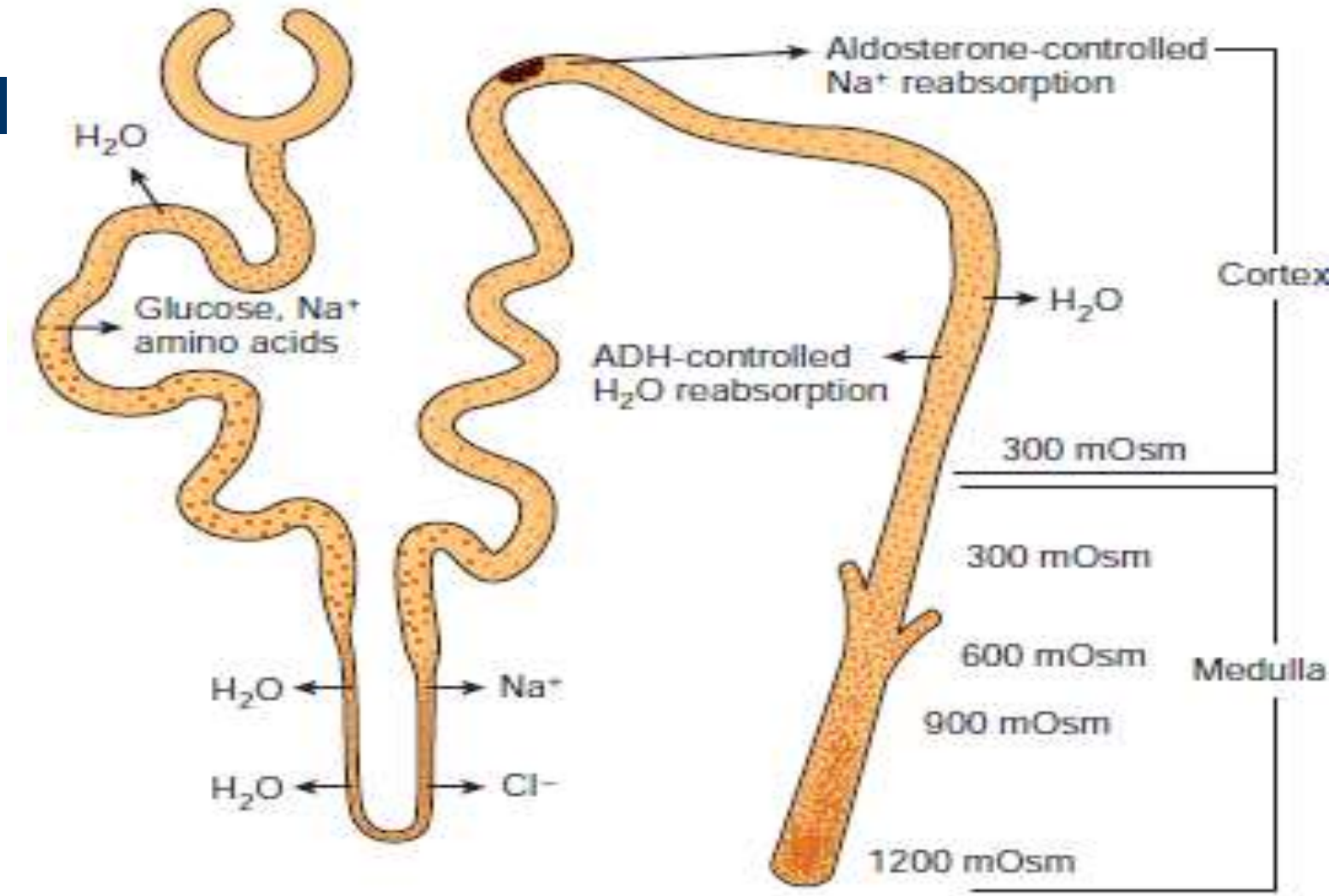
Renin-Angiotensin-Aldosterone System

- Controls the regulation of the flow of blood to and within the glomerulus.
- responds to changes in blood pressure and plasma sodium content.
- if we have low plasma sodium then RAAS:
  - decreases water retention
  - resulting in a decreased overall blood volume
  - causing decrease in blood pressure.

Renin-Angiotensin-Aldosterone System

- ***Renin*****,** an enzyme in juxtaglomerular cells, reacts with *angiotensinogen* to produce the hormone angiotensin II.
- Angiotensin II :
  - stimulate reabsorption of Na^+ (vasodilation)
  - release *aldosterone* (Na^+ reabsorb)
  - release of ADH(water reabsorb)
- Every minute 2 million glomeruli filter 120 mL.

Tubular Reabsorption



Tubular Reabsorption

- *Active transport:* reabsorption of glucose, amino acids, and salts (sodium, chloride).

- *Passive transport:* movement of molecules across a membrane as a result of differences in their concentration or electrical potential on opposite sides of the membrane (water, urea, sodium).

Tubular Reabsorption

- *Renal threshold:*
  - Reabsorbed substance is abnormally high in plasma (max. reab. capacity)
  - Active transport will stop
  - The substance will appear in the urine

Tubular Reabsorption

- Renal threshold for glucose is 160-180mg/dL (if glucose in urine: diabetes mellitus).

- **BUT,** glucose in urine of a person with normal blood glucose level is the result of tubular damage.

- Proximal tubule remove medication after they are dissociated from their carrier proteins.
- Descending loop: Water is removed by osmosis.
- Ascending loop: Na+ and Cl- are reabsorbed.
- Tubular secretion eliminate waste products, and regulate acid-base balance by secretion of H+.

- Reabsorption by osmotic gradient depend on vasopressin (ADH):
  - Decrease body hydration will increase ADH level which will cause decrease urine volume.

Renal Function Tests

- Glomerular Filtration Tests, its standard test is the *clearance test*, such as:
  - ✓ Inulin Clearance……. *Not used*
  - ✓ Creatinine clearance…. *Muscle waste*
  - ✓ Beta2 macroglobulin…. *Leukocyte Ag*
  - ✓ Cystatin C.... broken and reab. by tubular, measured in serum for pediatric, diabetes, critically ill patient
  - ✓ Radioisotopes……. *(^{125}I-iothalamate)*

Clearance Tests

- Urea newly is not used for this test because 40% of the filtered urea is reabsorbed, and this will reflect the result.
- Creatinine clearance is a frequently requested laboratory procedure, to determine the extent of nephron damage in known cases of renal disease.

Renal Function Tests

- Tubular Reabsorption Tests:
- ✓ Tubules function is the first affected in renal disease.
- ✓ Measurement done by *concentration tests* for salts and water.
- ✓ Assessed through osmometry.

Renal Function Tests

- Tubular Secretion and Renal Blood flow Tests:
  - ✓ measure substance that is secreted rather than filtered through the glomerulus.
  - ✓ The principle is the same as in the clearance test for glomerular filtration.
  - ✓ Test is carried out by measuring:
    - ➢ *P*-aminohippuric acid (PAH)… (exg.)
    - ➢ pH, titratable acidity, ammonia… (endo.)