Renal Physiology:

- **Organ Components:**
- **Function:**

- **Kidney Function:** “Blood filter”
  1. Regulates blood concentrations of: 
     \( \text{Na}^+, \text{Cl}^-, \text{Ca}^{2+}, \text{K}^+ \)
  2. Regulates:
  3. Regulates:
  4. Eliminates: 
     (urea & uric acids – protein, urobiligen)
  5. Secretes: 
     (Erythropoietin & rennin)

\( \Rightarrow \) **Produce blood filtrate:**
- ✓ Excess:
- ✓ Excess:
- ✓ Excess:

- Maintain: **Solute Concentration & Volume**

Note: LIVER functions to maintain:

- **Mechanism:** a.
  - b.

- **GOAL:** Separate valuable blood constituents from:

  \( \Rightarrow \) **Result:**
  - ✓ Urine:
  - ✓ Valuable constituents: Re-absorbed:

- **Kidney Filtering Rate:**

  \( \Rightarrow \) **Kidney Blood Perfusion Rate:**
  - 1.2 liters blood through kidneys per min
  - **Filtrate formation:**

- **Kidney Urine Production Rate:**

  \( \Rightarrow \) Urine Produced:

  \( \Rightarrow \) **Blood Volume filtered:**
Functional Kidney Unit:

- Human kidney contains:
  - Each manages a small volume of blood

- Mechanism of Action: **Three Step Process**:
  1. **Filtration**: Bulk separation by SIZE
     - Separate all:
       - Blood Cells, Large (functional) Proteins
  2. **Re-absorption**: Return to blood all valuable
     - Glucose, fatty acids, minerals, electrolytes, etc
  3. **Secretion**:
     - Micromanage blood by adding back into filtrate:
       - Components added back will be excreted with urine
       - Primarily:

Blood Filtration: Separation by:

- Site:

- 3 Level Filter:
  a. **Glomerulus**: “Tuft of Fenestrated Capillaries”
    - **Fenestrae**:
      - Increase:
      - Increases:
    - **Hydrostatic pressure**:
      - Large valuable components are NOT:
        - Blood cells and large & Medium proteins:
      - Small components filtered through:
  b. **Basement Membrane** (Basal Lamina)
    - Thick:
    - Prevent filtration of:
  c. **Podocytes with interlacing pedicles**:
    - filtration slits further filter:

- Filtered components referred to as:
  - Contains BOTH:
“Caught” by the:

Filtrate re-absorption:

- Reclaim:
  - Site:
  - Return to blood through:

☆ Renal Tubule: Specifically reabsorb:
  a. Proximal Convoluted Tubule
    - ~99%:
    - ~65%:
  b. Loop of Henle
    - ~20%: Additional:
      ⇒ Total of ~85% Salt & Water

Filtrate Secretion:
  a. Distal Convoluted Tubule
    - Secretion of excess ions ($K^+$) & minerals & toxins
    - Further reabsorb:

Nephron Completion:
  ⇒ Filtrate remaining exits:
    ✓ Referred to as:
    ✓ NO further significant adjustment to composition are made EXCEPT:
  ⇒ Urine collected by the:
    • Collecting ducts will alter:

✓ Urine:
  • PCT Epithelial Reabsorption:
    ⇒ Components Re-absorbed:
      ✓ 65% Water & Salt
      ✓ 99% Organic Nutrients
    ⇒ Utilizes:
      ✓ Expends 6% of:
  1. Basolateral Cell surface:
Primary Active:

Pumps: 3 Na⁺ OUT & 2 K⁺ into cell

- **Goal:** Decrease intracellular:
- **Goal:** Create gradient for:

2. Apical- Luminal cell surface:

- **Co-transport** of:
  - Uses concentration gradient created by:

- **Na⁺ diffusion INTO**:
  - Creates positive:
  - Draws in:

3. Basolateral Cell surface:

- **Facilitated diffusion** of Cl⁻
  - Uses concentration gradient to diffuse:

4. Apical- Luminal cell surface:

- **Na⁺ & Cl⁻** inside cell increases cellular:
  - Stimulates:

![Diagram of kidney structure](image)

Results: a. Reabsorbed:

b. Reduced filtrate volume by 1/3

- **Glucose Reabsorption: PCT**

1. Apical – Luminal Cell surface:

- **Co-transport** of Na⁺ &:
  - Uses concentration gradient created by:

2. Basolateral Cell surface:

- **Facilitated diffusion of**:
  - Uses concentration gradient to diffuse:
    - GLUT2 Channels
Diffuses from HIGH cellular conc. to:

⇒ Effectiveness:

Clinical Application:

• Normal Blood glucose concentration: 75-110mg/100dL blood
  ⇒ Glucose Channels can reabsorb:

• Diabetes Mellitus: Elevated blood glucose
  > 180mg / dL blood
  ⇒ Glucose Channels can NOT:
  ✓ Glucose excreted in URINE:

• Following PCT Reabsorption:
  ✓ ~99%: Nutrients Reabsorbed
  ✓ ~65%: Salt & Water Reabsorbed

⇒ Filtrate volume reduced by 2/3

Study Questions:

1) What are the 5 main functions of the kidney with respect to renal physiology and to homeostasis?
2) What is the structural and functional unit of the kidney? What is its primary general function?
3) What are the approximate average kidney blood filtration rates and urine production rates?
4) Explain why in the overall process of separating the “good” blood components with those that are “waste”, the first level of separation is filtration (separation according to SIZE)?
5) Why are the capillaries fenestraed? What functions does this serve?
6) Explain how the Renal corpuscle functions to produce an extremely specific filtrate? Which blood components will become filtrate and which will NOT? Why are blood cells and proteins normally not found in the filtrate (and therefore urine).
7) Once the filtrate is produced, what happens to the valuable filtered components? Where does this occur?
8) What would happen if the valuable filtered components were NOT reabsorbed?
9) What is the difference between absorption and secretion? Where does this occur within the nephron?
10) When is the filtrate referred to as urine?
11) What is the collecting duct capable of doing to the composition of the urine?
12) Describe the mechanisms involved which result in the absorption of sodium. Describe what events occur on the basolateral and luminal sides of the kidney cells.
13) Describe how the absorption of sodium is integral to the absorption to chloride, water, glucose and amino acids.
14) In which region of the renal tubule does most to the absorption occur? Into what structures do the reabsorbed substance travel?
15) Why is hyperglycemia (characteristic of diabetes mellitus) associated with glycosuria? Explain why the renal glucose threshold is 180mg/dL.
16) Normally protein and blood cells are NOT found in the urine. Why is protein in the urine (proteinuria) and blood cells in the urine are not commonly found in urine. Explain why you think hypertension is often associated with proteinuria and blood in the urine?
17) If the absorption of sodium is important for the reabsorption of chloride, water, glucose and protein, do you think it is possible to maintain homeostasis without sodium in the diet? Why or why not?
18) Why is it efficient for the nephrons to separate first according to size and then specifically reuptake and micromanage the smaller constituents?
19) How much filtrate remains following reabsorption within the proximal convoluted tubule?
20) Why does the kidney reabsorb 99% of the organic nutrients? (Hint: Where is the nutrient balance maintained? – what organ?)