Learning objectives:

1. Recall the location of the juxtamedullary nephrons.
2. Explain the change in permeability along the renal tubule to ions and water.
3. Explain the importance of the osmotic gradient in the kidney medulla.
4. Explain RAAS and the conditions that activate it.
5. Explain the hormonal regulation of ECF volume.
6. Define diuresis and explain the different causes of diuresis.
OSMOLARITY & VOLUME IN TUBULES

- Kidney can conserve water but cannot replenish water.
- Only water excreted by the kidney can be regulated.
- Normal urine mOsM changes with body’s need.

<table>
<thead>
<tr>
<th>Location</th>
<th>Volume (L/day)</th>
<th>mOsM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bowman’s capsule</td>
<td>180</td>
<td>300</td>
</tr>
<tr>
<td>end PCT</td>
<td>54</td>
<td>300</td>
</tr>
<tr>
<td>end loop of Henle</td>
<td>18</td>
<td>100</td>
</tr>
<tr>
<td>end CD (final urine)</td>
<td>1.5</td>
<td>50-1200</td>
</tr>
</tbody>
</table>
1. Standing osmotic gradient in medulla.

2. Descending Thin Loop of Henle is permeable to water but not to Na+.

3. Thin Loop of Henle is permeable to water and Na+.

4. Ascending Thick Loop of Henle is permeable to Na+, K+ and Cl- but not to water.
VASOPRESSIN (ADH) FUNCTION

Increases reabsorption of water in distal tubule & collecting duct to concentrate urine.

Acts to dilute ECF osmolarity & increase blood pressure.
ALDOSTERONE FUNCTION

Increases reabsorption of Na+ & secretion of K+ by principal cells.

Acts to increase ECF volume & blood pressure (BP).
RENIN-ANGIOTENSIN II-ALDOSTERONE SYSTEM (RAAS)

RAAS = coordinated response increases 2 vasoconstrictors (ADH & ANGII) and aldosterone in circulation.
EXCESS VOLUME

Blood Osmolarity < 280 mOsM → Hypothalamus → Secretion of Vasopressin (ADH) → Increased BP → Increased atrial stretch → Atrial Natriuretic Factor (ANF) → KIDNEY → Increases GFR & water loss to urine
DIURESIS
(increased loss of body water to urine, > 1 ml/min)

- **Water diuresis** – decreased osmolarity of plasma and/or increased blood volume leading to *decrease* in antidiuretic hormone (ADH) levels. Urine output *increases*.

- **Osmotic diuresis** - osmotically active substance (e.g., glucose) within renal tubule. Urine output *increases*.

- **Diuretics** - drugs that increase loss of body water primarily by *inhibiting* Na+ reabsorption by the renal tubule. Diuretics act at different segments of the renal tubule. Urine output *increases*. 
KEY CONCEPTS

1. Two-thirds of the body’s water is in the ICF; one third in the ECF. The ICF and ECF are in osmotic balance.

2. Kidneys’ primary functions are (1) to maintain body fluid volumes by regulating salt balance & (2) to maintain the osmolarity of the body by regulating water balance.

3. Reabsorption and secretion of water and solutes is governed by gradients and secondary active transport.


5. Increased urine excretion above 1 mL/min is called diuresis. There are several causes including: water, osmotic and diuretic. Diuretics primarily inhibit Na+ reabsorption.