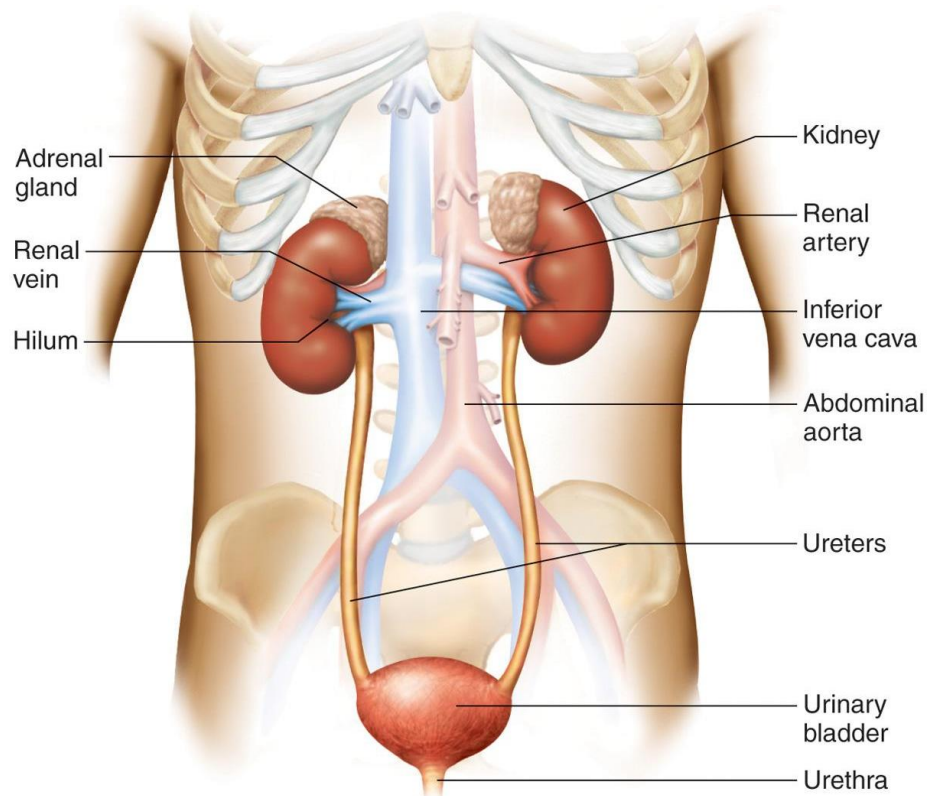


Human Physiology

Lecture 12 – Monday 21/3/2016

“Tubular Secretion, Urine Excretion & Plasma Clearance” with Dr. Khalid Talafih



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PSU

Note: (B) means a concept coming from the book, which was not included in the lecture.

Hypertension

- Hypertension is an abnormal increase in blood pressure.

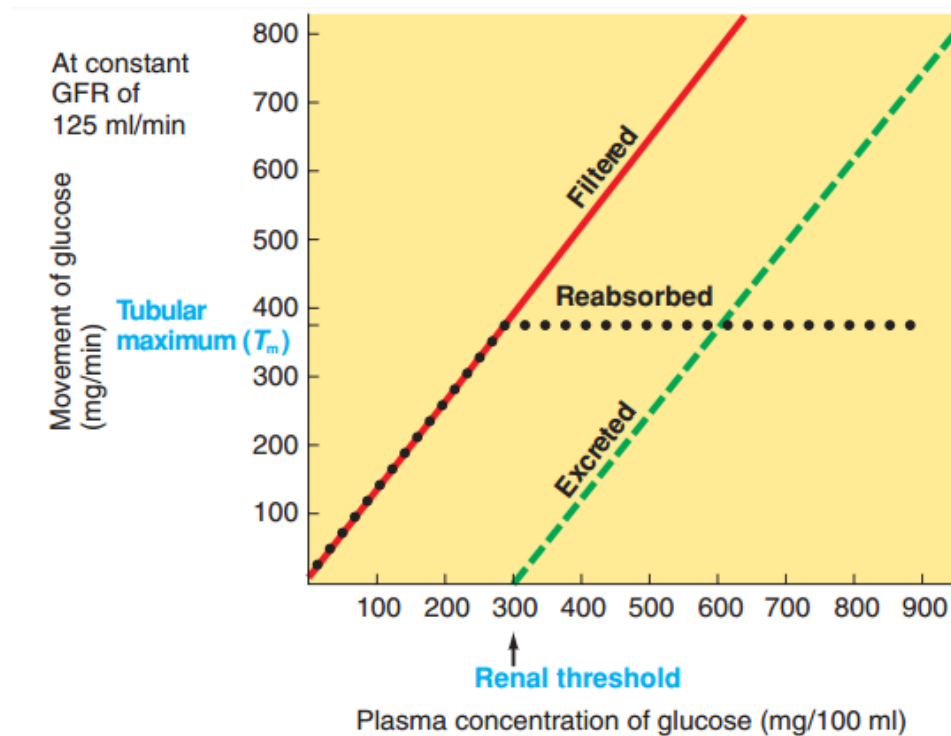
In the atrium, we have special cells called **atrial natriuretic peptide (ANP)**

- ANP is a hormone produced in the atrium as a result of expansion (تضخم) of the atrium.
- ANP inhibits (يمنع) the reabsorption of Na^+ in the distal tubule... because reabsorption of Na^+ includes reabsorption of H_2O as well, so when we stop reabsorption of water we decrease blood volume.
- So ANP
 - Lowers blood pressure
 - Decreases cardiac output or blood volume

Reabsorption of glucose & amino acids

- Glucose and amino acids are completely reabsorbed (in the proximal tubule), by the secondary active transport mechanism [when Na^+ is absorbed, Glucose and amino acids are reabsorbed].
- There are special carriers located only in the proximal tubule [carriers for Glucose and separate carriers for amino acids, and the carriers have different functions. So the carrier for glucose cannot transport amino acids, and the carrier for amino acids cannot transport glucose]. The carriers are also limited in number.
- When these carriers are saturated (full), we say they have reached a **Tubular Maximum (T_m)**.
- The normal concentration for glucose is 100mg per 100mL.
 - So when 100mL of plasma is filtrated, 100mg of glucose is present in it.
- The tubular maximum for Glucose is 375mg/min.
- The quantity of any substance filtered every minute is called **filtered load**.
 - Filtered load = plasma concentration * GFR of the substance
 - So, filtered load of glucose = $100\text{mg}/100\text{mL} * 125\text{mL}/\text{min} = 125\text{mg}/\text{min}$

- If the GFR is constant, the filtered load is proportional to plasma concentration. So if the concentration of glucose is doubled, the filtered load is doubled. If the concentration of glucose is tripled, then the filtered load is tripled.
- If the filtered load of glucose exceeds or is above 300mg/100mL (more than 3 times the normal amount), it starts spilling into urine. [Note: It is 300mg/100mL only ideally (نظريا), in reality glucose starts to spill into urine at 180mg/100mL. This is because in reality => there are nephrons of different sizes and functions, and not all of them work at the same time].



- The plasma concentration at which the tubular maximum has been reached, and the substance starts to appear in the urine is called **Renal threshold**.

Reabsorption of water

- Reminder: 65% of H_2O is reabsorbed in the proximal tubule by osmosis, and 15% is reabsorbed in the loop of Henle. The remaining 20% is reabsorbed in the distal tubule. Remember that the distal tubule is the part that can be controlled or regulated by hormones.
- So 80% (65+15) is **not** regulated by hormones. However, the remaining 20% in the distal tubule is controlled by hormones (ADH – Anti Diuretic Hormone)

- Unlike Sodium or Glucose, there are no carriers for water. H₂O moves by osmosis through **aquaporins** (or “**water channels**”). The difference is that carriers require energy.
- ADH controls the permeability of the water channels in the cell membrane.

Tubular secretion

- Tubular secretion is the selective movement/transfer of substances from the blood to the filtrate (by active transport mechanisms)
- The most important substances that are secreted are hydrogen ions (H⁺), potassium ions (K⁺), and other organic anions & cations.
- The major function of tubular secretion is regulating hydrogen and potassium ion concentration.
- About 65% of potassium ions are reabsorbed in the proximal tubule. Around 25% is reabsorbed in the loop of Henle. The remaining 10% is reabsorbed in the distal tubule, the part that is controlled by hormones (aldosterone).
- If aldosterone is not present, potassium ions will be completely reabsorbed (and 2% of Na⁺).
- Tubular secretion is also very important because it regulates the acid-base balance (pH) of the body.

During acidosis (decrease in blood pH // increase in H⁺ concentration), the body starts to reabsorb Na⁺ & starts to secrete H⁺ ions into the filtrate.

Plasma clearance (not required – مش مطلوب للامتحان)

- Plasma that enters the kidneys is not the same as plasma leaving the kidneys because substances like proteins are left behind. (B) By excreting the substances into urine, the kidneys clean or “clear” the plasma from these substances.
- **Plasma clearance** of a substance is the volume of plasma that has been completely cleaned of it per minute. (B) Plasma clearances expresses the effectiveness of the kidney in removing substances from the fluid environment.

Note: The material in here is from the lecture and from the book [Chapter 13 – Urinary System, pages 418 to 425]