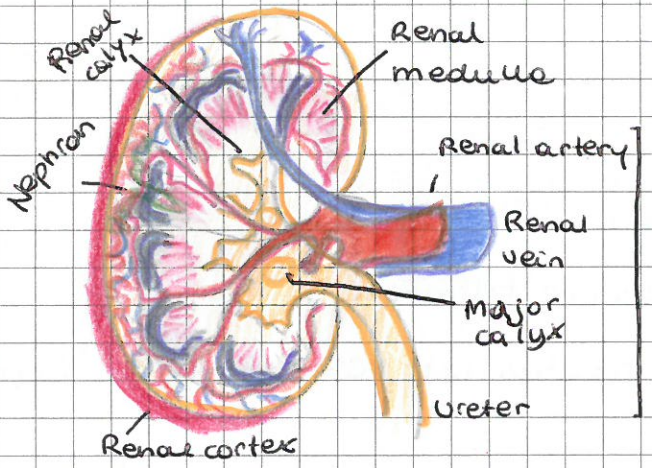
The kidney



Although most people think that the main function of the kidney is the removal of waste products

Renal Pelvis

actually the most important function of the kidney is the homeostatic regulation of the water and ion content of the blood, i.e SALT AND WATER BALANCE (or fluid and electrolyte balance) Main kidney functions are carried out by the NEPHRON, the kidney's functional unit. It's responsible for Filtration and collection. Homeostasis consists in balancing blood pH and pressure, and waste (UREA).

- Functions of the kidney
  - Regulation of the ECF volume and blood pressure
  - Regulation of osmolarity (~ 290 mOsM)
  - Maintanance of ion balance
  - Homeostatic regulation of pH (H^+ and bicarbonate)
  - Excretion of wastes - drugs, toxins
  - Productions of hormones

The kidney regulates a list of ions:

- Na^+
- K^+
- Cl^-
- Ca^{2+}
- H^+
- Magnesium and phosphate

tion gradient

i.e. tubule fluid (and hence urine) become concentrated.

Role of Vasa Recta

- Vasa recta capillaries accompany the loop as it dips into the medulla
- Role is to:
  - -> prevent washout of solutes from interstitial fluid (thus maintains the loop osmotic gradient)
  - maintains osmolarity of plasma
- Filtrate entering the descending limb becomes progressively more concentrated as it loses water

Blood in the vasa recta removes water leaving the loop of Henle.

The ascending limb pumps out Na^+ and Cl^-, and filtrate becomes hyposmotic.

Sodium balance

Renal regulation of Na^+

- Total body Na^+ varies by only a few percent
- Sodium excreted = Na^+ filtered - Na^+ reabsorbed
- Thus adjustment of Na^+ excretion can be achieved by:
  1. altering filtration (ie GFR)
  2. Altering reabsorption (major long term control)
- As Na^+ excretion is linked to water excretion such adjustments will also control blood volume (and thus pressure).
- Control factors:
  - Nervous
  - Hormonal

Hormonal regulation of Na^+

- The most important hormone is aldosterone
- It forms part of the renin-angiotensin-aldosterone system.
- Aldosterone is secreted by the zona glomerulosa of the adrenal cortex
- Aldosterone stimulates Na^+ reabsorption
- Aldosterone acts on collecting duct cells

Mechanism of Aldosterone-Induced Na^+ Reabsorption

- Aldosterone evokes the protein synthesis of:
  1. Increased Na^+ channels (apical membrane)
     Also increased K^+ channels
  2. Increased Na^+/K^+ ATPase pumps (basolateral membrane)
- Both will aid Na^+ reabsorption / K^+ secretion

Controls of Aldosterone release

- Plasma Na^+ concentration (low)
- Changes in extracellular volume (reduced)
- Angiotensin II
- Plasma K^+ concentration (high)

Angiotensin II

- Plasma concentration of angiotensin II is high in Na^+ depleted states:
  - sweating
  - diarrhoea
- Angiotensin II has 3 effects:
  1. causes aldosterone release
  2. causes vasoconstriction of afferent arterioles (decreases GFR and so increases Na^+ retention)
  3. Increases Na^+ reabsorption by a direct effect on the tubule