2003b(14)/1999b(4): Outline the role of the kidney in the regulation of body water

General: Kidneys are the primary method by which body water is regulated
- Receives 25% (1250ml/min) resting CO
  o Produces high volumes of ultrafiltrate

**Body Water Regulation**
- Important in homeostasis
  o Optimal size/vol body fluid compartments
  o Compartment osmolarity
- Water balance: Input = Output

Filtration: Blood is filtered through renal corpuscle to form ultrafiltrate
  o GFR ~180L/day

Reabsorption:
- Reabsorption of H₂O & electrolytes is determined by pressure, osmolarity via direct effects and hormone release

**Tuboglomerular Feedback** (part of autoregulation)
- Intra-renal osmoreceptors (macula densa)
  o ↑renal perfusion pressure → ↑GFR → ↑tubular fluid osmolarity (via ↑Na/Cl) → detected by MD → ↑adenosine → constrict afferent arteriole
  o ↓renal perfusion pressure → ↓GFR → ↓tubular osmolarity → detected by MD → NO release → dilate afferent arteriole
- Maintains GFR constant MAP 75 – 175mmHg in combination with myogenic mechanism.

**Myogenic Mechanism**
- ↑stretch afferent arteriole: via myogenic mechanism → ↑ stretch → reflex contraction of afferent smooth mm
  o Autoregulates filtration pressures over wide MAP

**Pressure:**
- ↑MAP
  o ↑Stretcher atria → release of ANP → ↓afferent tone/↑efferent tone → ↑GFR
    ▪ Diuresis
    ▪ Inhibition RAA system/ADH
  o Detected by central baroreceptors → ↓ADH from post pituitary → ↓ADH-urea transporters in CD / ↓aquaporin insertion CD
    ▪ ↓renal medullary osmolarity (↓urea reabsorption)
    ▪ diuresis
- ↓MAP
  o ↓stretch central/peripheral (RA, great vv) baroreceptors → 10% ECF vol loss → ↑ADH post pituitary (↑rapidly beyond 10% loss)
    ▪ MOA: binds V₂ receptors in CD → ↑cAMP → opens aquaporins
    ▪ ↑ADH-urea transporters → ↑urea reabsorption into medullary interstitium

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Renal

- ↑renal medullary osmolarity → ↑concentrating ability of kidney → ↑H₂O reabsorption
  - ↓afferent arteriolar pressure → detected by intrarenal baroreceptors → Stimulate renin release granular cells JGA → cleaves angiotensinogen → ATI → ACE (lungs) ATII → Aldosterone release from adrenal cortex
    - ↓GFR
    - ↑Na⁺/H₂O reabsorption from CD
    - ↑SVR
  - ↓stretch high P baroreceptors (carotid sinus/aortic arch)
    - Removal inhibition SNS
      - ↑CO, ↑SVR
      - ↑Renin release (β₁ stimulation)
    - Constrict afferent/efferent arterioles (α₁ stimulation) → ↓GFR

Osmolarity
- Central osmoreceptors
  - ↓osmolarity (<280mosm) of vascular compartment (excess H₂O) → ↓ADH from post pituitary → ↓H₂O reabsorption → large vol dilute urine
  - ↑osm (>300mosm) → ↑ADH → ↑H₂O reabsorption → small vol conc urine

Obligatory Urine Loss
- Solute load of 600mosm/day must be excreted
  - Urea, sulphates, phosphates, metabolic by-products)
- Min urine loss of 430ml to accommodate this
  - As max concentrating capacity of urine = 1400mosm/kg H₂O)