Renal Physiology
Work of the kidneys

Heart pumps 7000 l/day (32 55 gal drums).

1/4 (8 55 gal drums) through kidneys
Glomerulus –

Bowman's capsule passes (filters) 180 l/day.

And yet only 1 l of urine is produced per day.
(a) The urinary system

Kidney
Ureter
Urinary bladder
Urethra

(b) The kidneys are located retroperitoneally at the level of the lower ribs.

Diaphragm
Inferior vena cava
Right kidney
Aorta
Ureter
Peritoneum (cut)
Rectum (cut)
Urinary bladder
Left adrenal gland

(c) In cross section, the kidney is divided into an outer cortex and an inner medulla. Urine leaving the nephrons flows into the renal pelvis prior to passing through the ureter into the bladder.

Arcuate artery
Arcuate vein
Afferent arterioles
Glomerulus
Cortical nephron

(d) Renal arteries take blood to the cortex.

Renal artery
Renal vein

(e) Afferent arterioles and glomeruli are all found in the cortex.

Cortex
Renal pelvis
Ureter
Capable
Nephrons
(f) The capillaries of the glomerulus form a ball-like mass.

(g) Each nephron has two arterioles and two sets of capillaries associated with it.

(j) Parts of a nephron
- Glomerulus
- Bowman’s capsule
- Proximal tubule
- Distal tubule
- Collecting tubules
- Ascending limb of loop begins
- Descending limb of loop begins
- Collecting duct
- Loop of Henle
- To bladder
- Efferent arteriole
- Juxtaglomerular apparatus
- Afferent arteriole
- Peritubular capillaries
- Peritubular capillaries
- Vasa recta
- Collecting duct
- Loop of Henle

(i) Some nephrons dip deep into the medulla.

(h) Juxtamedullary nephron with vasa recta
- Peritubular capillaries
- Glomerulus
- Vasa recta
- Collecting duct
- Loop of Henle

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(a) The epithelium around glomerular capillaries is modified into podocytes.

(b) Micrograph showing podocyte foot processes around glomerular capillary.
(c) Podocyte foot processes surround each capillary, leaving slits through which filtration takes place.

(d) Filtered substances pass through endothelial pores and filtration slits.
Macula densa cells sense distal tubule flow and release paracines that affect afferent arteriole diameter.
Filtrate is similar to interstitial fluid.

**KEY**
- Membrane channel
- ATP = Active transporter

Tubule lumen

1. Na⁺ enters cell through open channels, moving down its electrochemical gradient.
2. Na⁺ is pumped out the basolateral side of cell by the Na⁺-K⁺-ATPase.
1. **Na⁺** moving down its gradient pulls glucose into the cell against its gradient.

2. Glucose diffuses out basolateral side of cell.

3. **Na⁺** is pumped out by **Na⁺-K⁺-ATPase**.
(a) Filtration of glucose is proportional to the plasma concentration.

(b) Reabsorption of glucose is proportional to plasma concentration until the transport maximum ($T_m$) is reached.

(c) Glucose excretion is zero until the renal threshold is reached.

(d) Composite graph shows the relationship between filtration, reabsorption, and excretion of glucose.
Low $\text{Na}^+$ intake → Low plasma $\text{Na}^+$ concentration → Hypothalamus → Posterior pituitary → ↓ ADH → ↓ Water reabsorption in collecting ducts → ↑ Urine volume, ↓ Blood volume → Juxtaglomerular apparatus → ↑ Renin → ↑ Angiotensin II → ↑ Aldosterone → ↑ Na$^+$ reabsorption in cortical collecting duct → ↑ Na$^+$ retention in blood → Juxtaglomerular apparatus → ↑ Sympathetic nerve activity
Vasopressin/ADH

• Vasopressin is released by the posterior pituitary and aids in water retention.
• Controls urine concentration in the collecting duct by reabsorbing water.
• ADH bind to it’s receptor and through a cAMP signal, Aquaporin-2 water pores are moved to the apical membrane.
• Water is recovered.
Effects of Alcohol

- Alcohol inhibits ADH secretion.
- Water recovery is significantly diminished and urine volume increases.