**Lecture 22 – Excretory System**

In this lecture, you will learn why water balance is important and how human kidneys function.

* Average human body is composed of 60% water.
  + Lungs: 90% water, Skin: 80% water, Blood: 82% water, Brain: 70% water, Muscle: 75% water, Bones: 22% water
  + Maintaining internal water balance, (osmoregulation), is extremely important.
* (Osmosis) is a special type of diffusion of water across a (selectively permeable) membrane
  + Water moves from an area of higher to lower free water concentration (lower to higher solute concentration).
  + Osmosis occurs whenever two solutions separated by the membrane differ in

(osmolarity).

* + Osmolarity: total solute concentration expressed as molarity (milliOsmoles/L )
  + Water flows by osmosis from a hypoosmotic solution to a hyperosmotic one (Fig. 44.2 [p. 954]).
    - Hyperosmotic: (High) solute concentration, (lower) free water concentration
    - Hypoosmotic: (lower) solute concentration, (higher) free water concentration
* Metabolic wastes must be removed.
  + Nitrogenous wastes are produced in the form of (ammonia), which is very toxic.
  + Ammonia is need to be (diluted) or (converted) to less toxic ones.
  + Nitrogenous wastes must be (dissolved in water) to be excreted from the body.
  + **Large impact on an animals’ water balance.**
* Three different types of nitrogenous wastes (Fig. 44.8 [p.958])
  + (Ammonia): highly toxic, highly soluble, easily lost by diffusion. Found in what animals?:
  + (Urea): very low toxicity, conversion from ammonia costs energy. Found in what animals?:
  + (Uric acid): nontoxic, does not dissolve in water, energetically very expensive. Found in what animals?:
* **Excretion** is the process that removes metabolic waste from the body through **osmoregulation.**
  + Excretion is different from defecation.
* 4 Main stages of excretion: (Fig. 44.10 [p.960])

(Filtration) 🡪 (Reabsorption) 🡪 (Secretion) 🡪 (Excretion)

1. Filtration: water and small solute from blood to excretory tubule

2. Reabsorption: valuable solutes (glucose, salt, vitamins, hormones, amino acids) and water back to blood

3. Secretion: nonessential solutes and wastes added to excretory tubule

4. Excretion: processed filtrate released as urine

\* Selectively permeable membrane in the excretory tubule makes filtering possible.

* Excretory system is an efficient filter system (Fig. 44.14 [p.962-963]).

You need to know the process of how blood is filtered through kidneys and excreted. Among the organs below, you need to be able to identify the names of each structure below and know the function of the structures with asterisk.

Kidney\*

Renal cortex, renal medulla, renal pelvis, renal artery, renal vein (renal means kidney)

Nephron\* - are functional units of kidney.

Glomerulus\* - a bowl of mesh

Proximal tubule\*

Loop of Henle\* (descending limb, ascending limb)

Distal tubule\*

Collecting duct\*

Peritubular capillaries, vasa recta

Ureter\*

Urinary bladder\*

Urethra\*

* Glomerulus is the site for (filtration).
  + Glomerular capillaries and epithelial tissues in the Bowman’s capsule are permeable to (water and small solutes), but not blood cells and large molecules.
  + Initial filtrate contains water, salts, glucose, amino acids, vitamins, nitrogenous wastes, etc.
* Specialized regions of a nephron are the sites for reabsorption and secretion
  + Direction of filtrate flow

Bowman’s capsule 🡪 (Proximate tubule) 🡪 (Loop of Henle) 🡪

(Distal tubule) 🡪 (collecting duct) 🡪 (Urine)

* + In the Loop of Henle, the descending limb is permeable to (water), but not to solutes, but the ascending limb is impermeable to (water), but to permeable to solutes. This is very important in establishing concentration gradient inside the kidneys.
* Flow of filtrate inside a nephron (Fig. 44.15, [p.964])

1. Proximal tubule: Reabsorption of ions, water, nutrients; Secretion of H+ and ammonia
2. Descending limb of Loop of Henle: Reabsorption of (water).
3. Ascending limb of Loop of Henle: Reabsorption of (salt).
   1. Salt diffuses out at thin segment (25%)
   2. Active transport of salt at thick segment (5%)
4. Distal tubule: Reabsorption of salt, water, bicarbonate; Secretion of K+ and H+
5. Collecting duct: Reabsorption of salt, water, urea

* Kidney concentrates urine by maintaining osmolarity gradient (Fig. 44.16 [p.966])
  + NaCl and Urea contribute to the osmolarity gradient
  + Countercurrent multiplier system: countercurrent system that expends energy to create concentration gradient

\* Know how osmolarity differs inside a kidney and how this gradient is maintained.

* Kidney has one of the highest metabolic rates of any organ
  + 1,600 L of blood flows through a pair of kidneys each day
  + Nephrons process 180 L of initial filtrates
  + 99% of water, sugar, amino acids, vitamins, nutrients are reabsorbed to blood
  + Produce 1.5 L of urine per day
* Some food we take are diuretic and can have effects on kidney function
  + Alcohol – inhibits ADH (antidiuretic hormone) secretion
  + Caffeine - inhibit reabsorption of Na+, increase glomerular filtration rate
* Excretory System Disorder
  + Gout: a painful inflammation of the joints caused by deposits of uric acid crystals
  + Nephrolithiasis (Kidney stone): when urine does not have the correct balance of fluid and a combination of minerals and acids
* Diverse excretory systems are built on a complex network of tubules (Fig. 44.11-13 [p.960-961])
  + Flatworms have (Protonephridia), branching internal tubules.
  + Annelids have (Metanephridia), which collect coelomic fluid from the adjacent anterior segment.
  + Insect have (Malphighian tubules), outpocketings of digestive tract that remove nitrogenous wastes.