

### The Importance of Excreting Wastes

- Many of the compounds created through normal body systems can become toxic if they build up in the body (see Table 1, p. 342)
- To maintain life processes, these toxins must be excreted
- The lungs eliminate  $CO_2$ , the bowels eliminate solid waste
- The liver transforms ingested toxins, like alcohol and heavy metals, into soluble compound that can be eliminated by the kidneys
- The liver also transforms the hazardous products of protein metabolism into metabolites, which are then eliminated by the kidneys
- The kidneys are also crucial in balancing blood pH and maintaining
- In order for proteins to be broken down in the body, the amino group must be removed from the amino acids, and the remainder of the molecule can be converted to carbohydrates
  
- This removal process, called deamination, occurs in the liver
- The byproduct of deamination is ammonia, a toxic water-soluble gas
- A build-up of as little as 0.005 mg can kill humans
- Fish avoid ammonia build-up by continually releasing it through their gills
- Land animals can not do this, and have to store the wastes temporarily
- In the liver, two molecules of ammonia combine with another waste product, carbon dioxide, to form urea
- Urea is 100 000 times less toxic than ammonia
- The blood can dissolve 33 mg of urea/100mL of blood
- A second waste product, uric acid, is formed by the breakdown of nucleic acids
- The kidneys help maintain water balance, essential because the average adult loses about 2L of water every day through urine, perspiration, and exhaled air
- Greater volumes are lost when physical activity increases
- For the body to maintain water balance, humans must consume 2L of fluid daily
- A drop in fluid intake by as little as 1% of your body mass will cause thirst, a decrease of 5% will bring about extreme pain and collapse, while a decrease of 10% will cause death
  
- For unicellular organisms, toxins will build up in the cell quickly (cell death)
- For these organisms and simple multicellular organisms which are in contact with their external environment all the time, wastes are released directly from the cell and carried away by water currents
- Unicellular organisms are hypertonic to their freshwater surroundings, without a system of fluid regulation, these cells would constantly draw in water by osmosis
- A contractile vacuole expels excess water, preventing the cell from swelling
- For complex multicellular organisms with multiple tissue layers, their cells are not in direct contact with the external environment, so they must store the waste for excretion (see Fig. 5, p.344)
- The excretory system also helps to regulate body water

### The Urinary System

- The kidneys are fed with blood from the renal arteries

- With a mass of 0.5kg, the kidneys hold as much as 25% of the bladder acts as a valve, permitting the storage of urine
- When 200mL has been collected, the bladder stretches slightly, sending a message to the brain
- When 400mL has been collected, the bladder stretches more, and the message becomes urgent
- When 600 mL has been collected, voluntary control is lost
- Urine leaves the bladder via the urethra
- The kidney is made up of three structures (see Fig.1, p. 347); the outer layer of connective tissue (the cortex), the inner layer (the medulla), and the hollow chamber (the renal pelvis) which connects the kidney with the ureter

### Nephrons

- The kidney is made up of one million slender tubules, called nephrons, the functional unit of the kidney (Fig. 2, p. 347)
- Small branches from the renal artery, the afferent arterioles, supply the nephrons with blood
- The afferent arterioles branch into a capillary bed called the glomerulus
- Unlike other capillaries, the glomerulus does not transfer blood to a venule
- instead, blood leaves the glomerulus by way of other arterioles, the efferent arterioles
- Blood is carried from the efferent arterioles to a net of capillaries called peritubular capillaries
- The glomerulus is surrounded by a funnel-like part of the nephron, called the Bowman's capsule
- These three structures are all found in the cortex of the kidney
- Fluids to be processed into urine enter the Bowman capsule, which tapers to a thin tubule, called the proximal tubule
- Urine is carried from the proximal tubule to the loop of Henle which descends into the medulla of the kidney
- Urine moves through the distal tubule, and into the collecting ducts
- The collecting ducts collect urine from many nephrons that merge in the pelvis of the kidney

### Homework

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