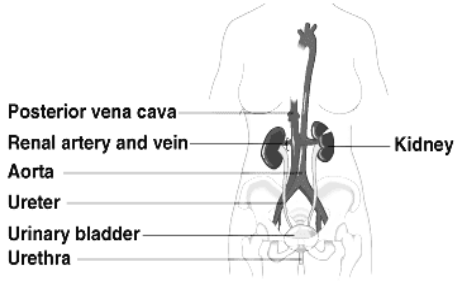
Excretion

Chapter 28

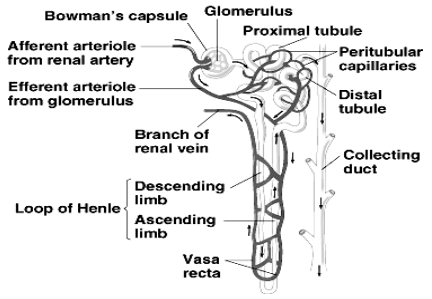
The Mammalian Excretory System consists of



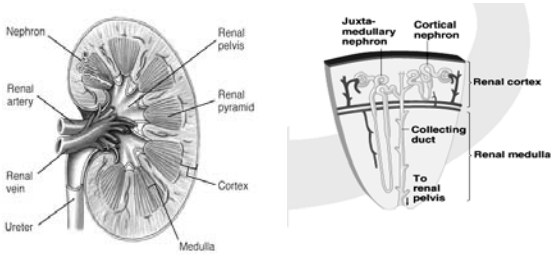
The Kidney

1. Vertebrate kidneys perform
   A. Ion balance
   B. Osmotic balance
   C. Blood pressure
   D. pH balance
   E. Excretion
   F. Hormone production

The Nephron: the basic unit of the kidney.



Kidney Structure



Vertebrate Kidney: Structure and basic function

1. About 20-25% of the total cardiac output goes to the kidneys
2. cardiac output: 3000 ml/min
3. Renal blood flow: 600 ml/min
4. Filtered 125 ml/min (~20%) or 180 l/day
5. Excreted 1.5 l/day (<1%)

Urine Production

1. (Ultra)Filtration
2. Reabsorption of selected salts, nutrients and water
3. Secretion
4. Excretion

First Step in Urine Production

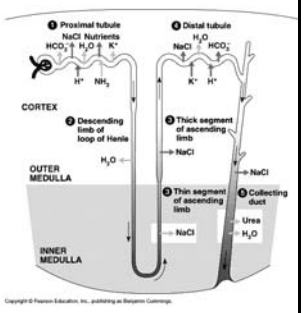
1. Ultrafiltration is non-selective
   A. Bowman's capsule and glomerulus
   B. Solutes of high molecular weight and blood cells are left behind.
   C. Advantage _____
   D. Disadvantage _____
2. Formation of primary urine

Nephron Structure

1. Tubule leads from the Bowman's capsule.
2. Divided into:
   A. Proximal tubule
   B. Loop of Henle
   C. Distal tubule
   D. Collecting tubule

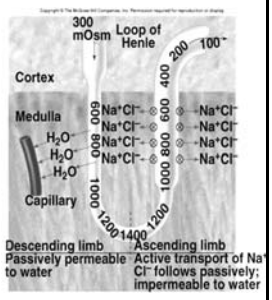
Proximal Convoluted Tubule

1. **Reabsorption** of water, bicarbonate, glucose, amino acids, sodium, etc.
2. **Secretion** of H^+ and NH_3



Loop of Henle

1. present in birds and mammals.
2. In the Descending limb, there is
   1) H_2O reabsorption
   2) No active or passive salt transport



Ascending Limb

1. Thin ascending limb
   A. No active salt transport
   B. High NaCl permeability
   C. Low H_2O permeability
2. Thick ascending limb
   A. Low H_2O permeability
   B. Active NaCl transport

Distal Convoluted Tubule

1. Reabsorbs more water and sodium, etc.
2. Secretion of H^+ and potassium.
3. Aldosterone affects permeability.

Collecting duct

1) the last chance to reabsorb sodium and water
2) Variable permeability to H_2O
3) Passive diffusion of urea
4) ADH regulates permeability

Endocrine hormones affect kidney function

1. Diuretics – stimulate excretion of water
2. Antidiuretics – reduce excretion of water
3. Steroid hormones – slow response (act over hours)
4. Peptide hormones – rapid response

Vertebrate Kidney: Structure and basic function

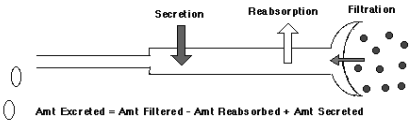
1. We filter our entire blood volume about twice an hour
2. Re-absorption is quite fine-tuned
3. Tubular maximum
4. Some poisons are specifically secreted to speed excretion from body

How Renal Function is Studied BOX 28.2

1.Net Process:

Amount of substance "A" in Urine =

Amount Filtered - Amount Reabsorbed + Amount Secreted



members.aol.com/Bio50/LecNotes/lecnot37.html

How Renal Function is Studied

1. Glomerular Filtration Rate (GFR).
   A. rate kidneys filter blood plasma
2. Substances used to measure GFR
   A. Inulin
   B. Creatinine

How Renal Function is Studied

1. V x U = GFR x P
2. where
   A. V = rate of urine production in, in mL/min
   B. U = urine concentration of "*A*", in mg/mL
   C. (VU = amount of inulin in the urine per minute)
   D. GFR = glomerular filtration rate of plasma, in mL/min
   E. P = plasma concentration of "*A*", in mg/mL
   F. GFR = VU/P

Solving for GFR ($V_{filtrate}$)

1. If
   1) Urine flow: V_{urine} = 1.2 ml/min
   2) Inulin in urine = 2%
   3) Inulin in plasma = 0.02%
2. Then
   4) $V_{filtrate}$ = Glomular filtration rate = 120 ml/min

How Renal Function is Studied

1. 99% filtrate is reabsorbed
2. In 24 hours, human kidneys reclaim
   A. ~1,300 g of NaCl
   B. ~400 g $NaHCO_3$
   C. ~180 g glucose
   D. almost all of the 180 liters of water that entered the tubules.

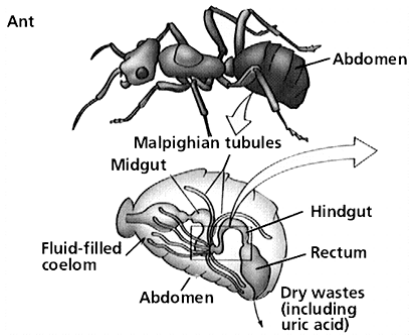
Clearance measurements

1. tell you how the kidney handles the substance:
2. Filtered only
   1) C = GFR (about 120 mL/min)
3. Filtered and then reabsorbed:
   2) C for that substance will be less than about 120 mL/min
4. Filtered and then secreted
   3) C for that substance will be higher than about 120 mL/min

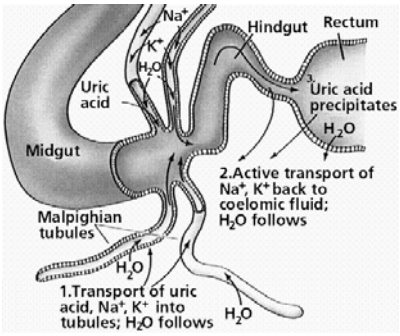
Alcohol and Caffeine

1. Alcohol inhibits ADH release from the brain.
2. Caffeine blocks ADH attachment to the collecting duct epithelium, increases glomerular filtration rate, and decreases the tubular reabsoption of Na.

Malpighian tubules



Excretion in Insects



Nitrogenous waste is related to reproductive strategy and habitat

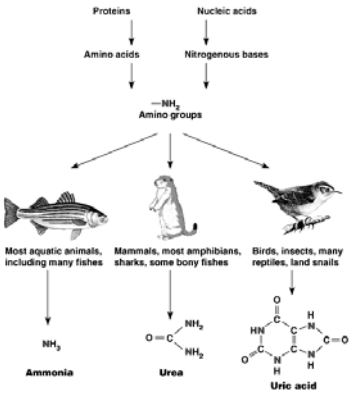


Fig. 28. 4 Nitrogen Excretion

Nitrogen Excretion: General

1. Most nitrogen in an animal's system is from digestion of proteins.
2. Excess nitrogen released during deamination of amino acids is usually in the form of NH_3.
3. Metabolism of nucleic acids and other nitrogen compounds also yields ammonia.

Nitrogen Excretion: Ammonia

1. Requires little energy to produce
2. Highly soluble and highly toxic
3. Requires large volumes of water to store and excrete
4. Ammonia is
   A. Excreted by teleosts, cyclostomes, and most invertebrates
   B. lost mainly through skin and gills
   C. no special organ needed

Nitrogen Excretion: Urea

1. Soluble and not too toxic
2. In sharks and marine frogs it is re-absorbed for osmotic balance
3. Tadpoles excrete ammonia, while frogs excrete urea
4. Lungfish excrete ammonia

Nitrogen Excretion: Uric Acid

1. An adaptation to reducing water loss in desert animals
2. Birds and reptile embryos in eggs need to excrete without losing much water
3. Water in cloaca and hindgut absorbed through osmosis
   A. active transport may also be involved