Renal II
Excretory and Osmoregulatory Mechanisms

- Protozoa and sponges
  - Diffusion and active transport through surface membranes
  - Water expulsion vesicles / contractile vacuoles
    - Osmoregulatory not excretory
    - Form from ER
Excretory and Osmoregulatory Mechanisms

- Cnidarians, Echinoderms, Marine sponges
  - Body surfaces
    - Cells on body surfaces regulate salt and water and eliminate wastes
    - Hydra use gastrovascular cavity to remove excess water
Protozoan

- Endoplasmic reticulum
- Excretory pore
- Ampulla
- Water expulsion vesicle (full) (empty)
Excretory and Osmoregulatory Mechanisms

• Bilateral animals have excretory organs
  • Tubular organs that regulate water, salt and waste concentrations in the body cavity and interstitial fluids and circulatory fluids
  - Tubular excretory / osmoregulatory organs
    • Collection mechanisms
      - Cilia beating within the tube
      - Fluids follow active transport of salt
      - Blood or hemolymph pressures
Excretory and Osmoregulatory Mechanisms

• Tubular excretory / osmoregulatory organs
  • Fluid in tube = filtrate
  • Reabsorption reclaims solutes
  • Secretion removes additional solutes

- Several types
  • Nephridia
    - Protonephridia, metanephridia
  • Antennal or maxillary glands
  • Malpighian tubules
  • Kidney
    - nephrons
Excretory and Osmoregulatory Mechanisms

• Protonephridia
  - Found in flatworms, rotifers, some annelids, larval molluscs, and lancelets
  - Nephridiopores and flame cells
  - Branching tubes ending in closed hollow bulbs
  - Bulbs formed by two cells
    • Cap cell with cilia, tubule cell
  - Urine voided through nephridiopores
Excretory and Osmoregulatory Mechanisms

• Protonephridia
  - Osmoregulatory structures in freshwater species
  - Hypertonic - stops beating of flame cells
  - Hypotonic - active

- Mechanism of urine formation
  • Not fully understood
Excretory and Osmoregulatory Mechanisms

• Metanephridia
  - Occurs in annelids
    • Fluid enters through nephrostome
    • Stored in a bladder
    • Fluid modified by reasorption
    • Fluid emptied through the nephridiopore
Excretory and Osmoregulatory Mechanisms

• Metanephridia
  – Occurs in annelids
    • Fluid enters through nephrostome
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Metanephrididia

- Dorsal blood vessel
- Capillary network
- Ventral blood vessel
- Nephrostome
- Intestine
- Nephridiopores

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Excretory and Osmoregulatory Mechanisms

- **Metanephridia**
  - Oligochaetes
    - Paried metanephridia in each segment
    - Produce high volume of urine (60%) body weight
    - Regulates salt and water balance
    - Ammonia exchanged thru the body surface
    - Under hormonal control by from the brain
Excretory and Osmoregulatory Mechanisms

- Crustacean antennal and maxillary glands
  - Insect malpighian tubules and hindgut systems
  - Vertebrate kidneys
    - Ureter, urinary bladder, urethra, collecting ducts, nephrons
Antennal Glands
Antennal Glands
Antennal Glands

- Labyrinth
- End Sac
- Biodidac
- Bladder
- Excretory pore
- Tubule
Excretory and Osmoregulatory Mechanisms

- Crustacean antennal and maxillary glands
  - Insect malpighian tubules and hindgut systems
Malpighian tubule
Excretory and Osmoregulatory Mechanisms

• Vertebrate kidneys
  - Paired and in dorsal wall of abdominal cavity
  - Compact, bean shaped and connect to ureter, urinary bladder and urethra
Excretory and Osmoregulatory Mechanisms

- Vertebrate kidneys
  - Receive blood supply from renal artery
  - High supply (40x other organs)
  - Humans = 1-2 liters per day!
  - 180 L/day of filtrate
  - Refined to about 1.5 L urine daily
Vertebrate kidney

• Functional unit = nephron
  - Parts = proximal and distal tubule, ascending and descending loop of henle, collecting ducts
  - Circulation
    • Peritubular capillaries
Vertebrates
Vertebrates
Vertebrates
Vertebrates
Excretory and Osmoregulatory Mechanisms

- Mammalian kidney physiology
  - Regulation
    - ADH and vasopressin, vasotocin
    - Osmoreceptors
    - Juxtaglomerular apparatus
    - Angiotensin
    - aldosterone
FIGURE 17–32  Mechanism for osmotic concentration of urine by countercurrent multiplication of solute concentration in the loop of Henle and adjacent interstitial fluid (int fluid) by active transport of Cl<sup>−</sup> (center). A passive countercurrent exchange of urea contributes to the interstitial osmotic gradient (right). There is a passive countercurrent exchange of solute and urea in the peritubular blood supply (vasa recta) to limit potential dissipation of the interstitial osmotic gradient by peritubular blood flow.
Excretory and Osmoregulatory Mechanisms

• Sea creatures and excess salt removal
  - Salt-excreting glands
    • Supraorbital salt gland (albatross)
    • Lachrymal salt gland (sea turtle)
    • Sublingual salt glands (sea snake)
    • Chloride cells (bony fish)
Mammalian kidney physiology

- Producing a concentrated urine
- Loop of Henle
  - Countercurrent exchange
- Collecting duct