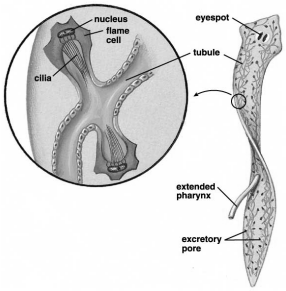
Chapter 35:
Urinary System

Urinary System:
('Excretory System')

Maintains homeostatic conditions within body fluids

Types of Animal Excretory Systems:

1) Protonephridia (e.g. flatworms):



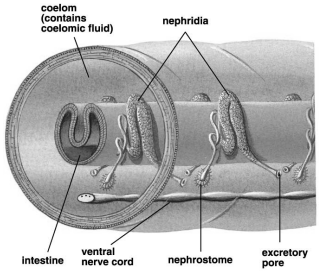
- Flame Cells:
  - Bulbous, ciliated cells; collect waste from body fluids
- Tube Network:
  - Convey waste to external pores
- Fluid moves via beating cilia

(Figure 35.1)

Types of Animal Excretory Systems:

2) Nephridia (e.g. earthworms, mollusks):

- Nephrostome: Funnel-shaped openings to body cavity; collect fluids
- Fluids pass into tube (movement = cilia)
- Nutrients / ions reabsorbed from tube into blood
- Waste (urine) expelled via excretory pores



(Figure 35.2)

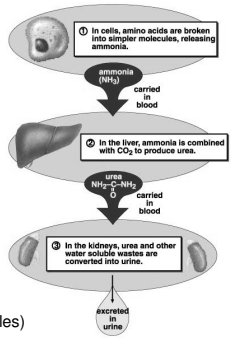
Human Urinary System:

The human urinary system ain't just for pee'n...

Homeostatic Functions:

1) Maintain water balance
2) Regulate [ion] (Na^+, K^+, Ca^{++}, Cl^-)
3) Maintain blood pH
4) Maintain blood pressure and [O_2] in blood
5) Eliminate cellular waste (e.g. urea)

Urea = Product of amino acid metabolism

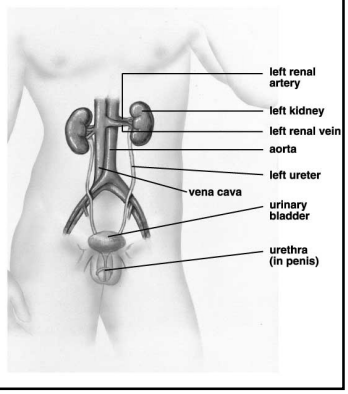


Uric Acid: Secreted by animals in xeric (dry) conditions (birds/reptiles)

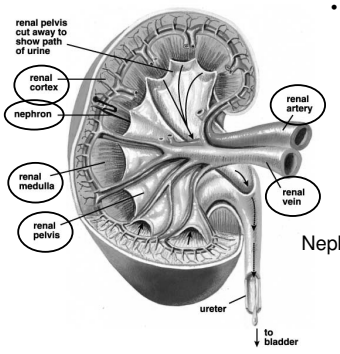
(Figure 35.3)

Human Urinary System:

1) Kidneys
   - Filter blood
   - Reabsorb nutrients
2) Ureters
   - Transport urine away from kidney
   - Movement via paristalsis
3) Bladder
   - Stores urine
   - Maximum capacity ~ 1 L
3) Urethra
   - Transport urine from bladder to outside body
   - Internal sphincter (invol.) External sphincter (vol.)



Gross Anatomy of the Kidney:

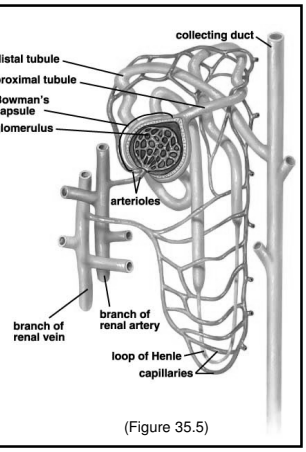


- 1/4 of cardiac output delivered to kidneys (1.25 L/min)

Nephron: Functional unit of the kidney
- 1 million / kidney

Nephron Anatomy:

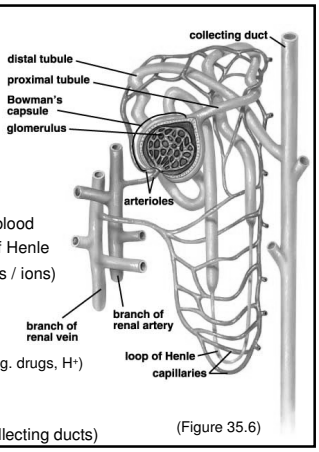
1) Glomerulus:
   - Capillary bed
2) Bowman's Capsule:
   - Collects fluids from blood
3) Tubule:
   - Conducting tube
   (a) Proximal Tubule
   (b) Loop of Henle
   (c) Distal Tubule
   (d) Collecting Duct



(Figure 35.5)

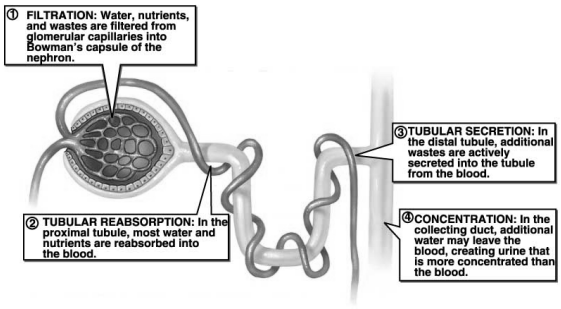
Nephron Physiology:

1) Filtration:
   - Movement of materials
   glomerulus → Bowman's capsule
   - Ions, nutrients, waste, water
     - Filtrate = Filtered fluids
2) Tubular Reabsorption:
   - Water / nutrients returned to blood
     - Proximal Tubule / Loop of Henle
     - Active Transport (nutrients / ions)
     - Osmosis (water)
3) Tubular Secretion:
   - Wastes / excess substances move from blood to filtrate (e.g. drugs, H^+)
     - Distal Tubule
4) Concentration:
   - Additional water removed (collecting ducts)



(Figure 35.6)

Summary of Nephron Physiology:



(Figure 35.6)

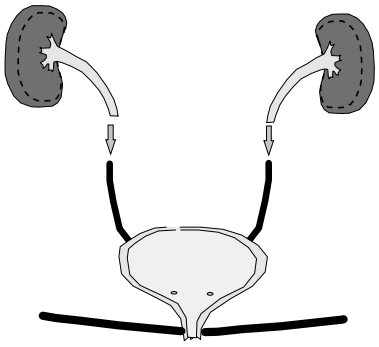
Urine: Waste and remaining water from nephron
- 95% water / 5% solutes (ions, urea)

(1) Color / Transparency:
- Dilute = Pale yellow / clear
- Concentrated = Deep yellow (Urochrome)

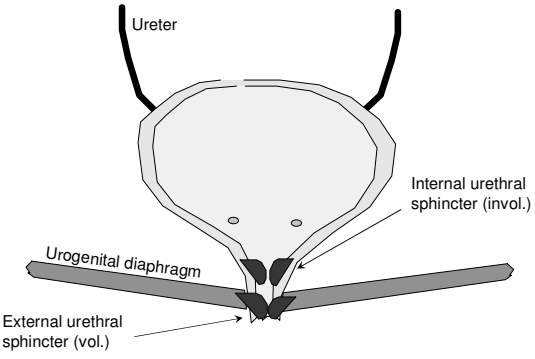
(2) Odor:
- Fresh = Slight odor
- Old = Ammonia odor (bacteria)

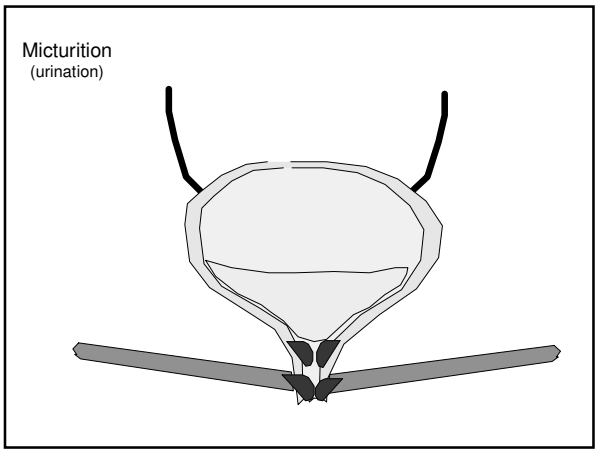
(3) pH:
- Acidic (pH ~ 6)

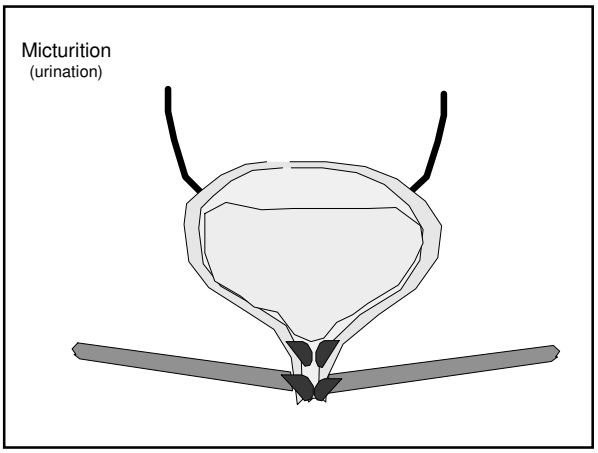
Micturition
(urination)

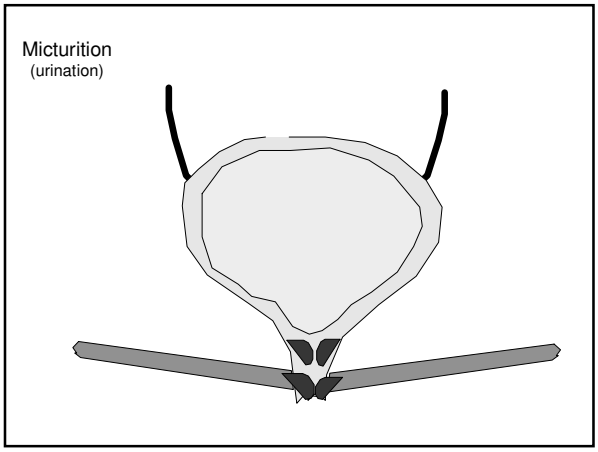


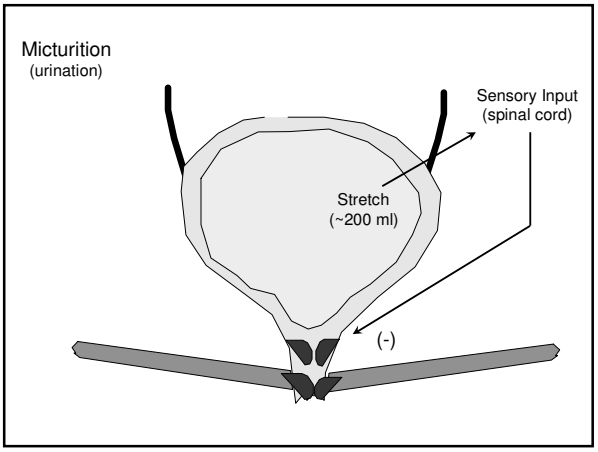
Micturition
(urination)

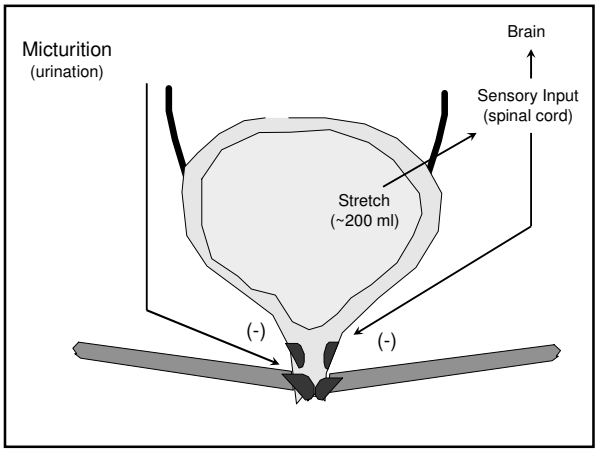


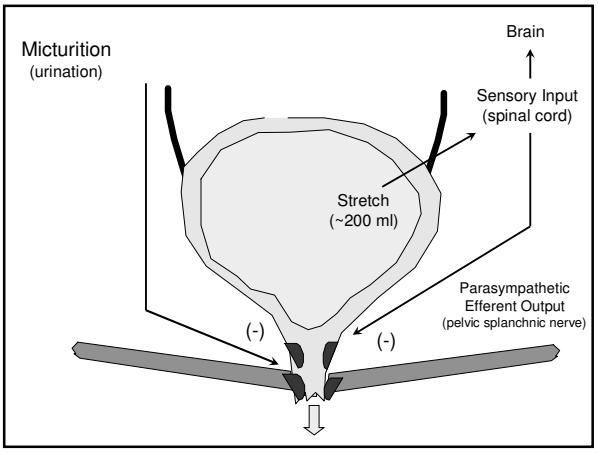

Micturition
(urination)


Micturition
(urination)


Micturition
(urination)


Micturition
(urination)
Sensory Input
(spinal cord)
Stretch
(~200 ml)
(-)


Micturition
(urination)
Brain
Sensory Input
(spinal cord)
Stretch
(~200 ml)
(-)
(-)


Micturition
(urination)
Brain
Sensory Input
(spinal cord)
Stretch
(~200 ml)
Parasympathetic
Efferent Output
(pelvic splanchnic nerve)
(-)
(-)

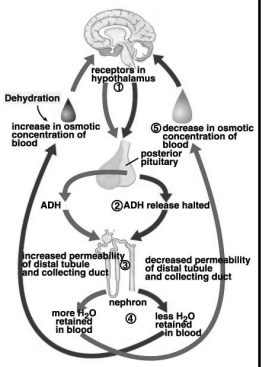
Homeostatic Functions of Kidney:

(1) Eliminate waste
(2) Balance [ion]
(3) Maintain pH

} Nephron of Kidney

(4) Regulate water balance:

- Collecting duct permeability variable
  - Impermeable = 22.5 L urine / day
  - Permeable = 1.5 L urine / day
- Permeability controlled via hormones
  - Antidiuretic Hormone (Pituitary)
    - Increases permeability
    - Controlled via negative feedback



(Figure 35.8)

Homeostatic Functions of Kidney:

(1) Eliminate waste
(2) Balance [ion]
(3) Maintain pH

} Nephron of Kidney

(4) Regulate water balance:

(5a) Regulate blood pressure:

- Low BP $\rightarrow$ Kidneys release renin
  - Catalyzes formation of angiotensin
    - Constricts arterioles (= $\uparrow$ BP)

(5b) Regulate $[O_2]$ in blood:

- Low $[O_2]$ $\rightarrow$ Kidneys release erythropoietin ($\uparrow$ RBCs)