Chapter 16
Urinary System and Excretion

Animals must dispose of nitrogenous wastes

- Nitrogenous wastes are toxic breakdown products

Nitrogenous wastes:
- Proteins
- Nucleic acids
- Amino acids
- Nitrogenous bases

Most aquatic animals, including most fishes
Mammals, amphibians, sharks, some bony fishes
Birds and many other reptiles, insects, land snails

Uric acid
Urea
Ammonia

The liver performs many functions, including the production of urea

The liver produces urea, breaks down toxins, produces bile, plasma proteins, and lipoproteins and it adjusts the nutrient content of the blood

Organs of the Urinary System
1. Kidneys
2. Ureters
3. Urinary Bladder
4. Urethra

Functions of the urinary System
1. Excretion of Metabolic Wastes
2. Maintenance of Water-Salt Balance
3. Maintenance of Acid-Base Balance
4. Secretion of Hormones
1. Kidneys produce urine.
2. Ureters transport urine.
3. Urinary bladder stores urine.
4. Urethra passes urine to outside.

- Nephrons, the functional units of the kidneys extract a filtrate from the blood and refine it to urine

- Urine leaves the kidneys via ureters
  - Is stored in the urinary bladder, and is expelled through the urethra
16.2 Anatomy of the Kidney and Excretion

<table>
<thead>
<tr>
<th>Filterable Blood Components</th>
<th>Nonfilterable Blood Components</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>Formed elements</td>
</tr>
<tr>
<td>Nitrogenous wastes</td>
<td>Plasma proteins</td>
</tr>
<tr>
<td>Nutrients</td>
<td></td>
</tr>
<tr>
<td>Salts (ions)</td>
<td></td>
</tr>
</tbody>
</table>

Becomes part of filtrate | Remains in blood

\[
\begin{array}{c|c|c|c|c|c}
\text{Substance} & \text{Amount Filtered (per day)} & \text{Amount Excreted (per day)} & \text{Reabsorption} \\
\hline
\text{Water, L} & 180 & 1.8 & 99.0 \\
\text{Sodium, g} & 630 & 3.2 & 99.5 \\
\text{Glucose, g} & 180 & 0.0 & 100.0 \\
\text{Urea, g} & 54 & 30.0 & 44.0 \\
\end{array}
\]

\(L = \text{liters}, g = \text{grams}\)

**Urine Formation**
- Nephrons filter about 180 liters of primary filtrate water per day
- Most of the water, nutrients and salt are reabsorbed
- Nitrogenous waste and toxins get excreted

**Major processes of the excretory system**
- Filtration: blood pressure forces water and many small solutes into the nephron
- Reabsorption: valuable solutes are reclaimed from the filtrate
- Secretion: excess \(H^+\) and toxins are added to the filtrate
- Excretion: The finished product, urine is excreted

Antidiuretic hormone (ADH) regulates the amount of water the kidneys excrete

Aldosterone regulates Na\(^+\) reabsorption
Regulatory Functions of the Kidneys

Acid-Base Balance

- Normal pH for most body fluids is 7.4
- Alkalosis: pH is greater than 7.4
- Acidosis: pH is less than 7.4

- Several Mechanisms Maintain a pH of ~ 7.4
  - Acid-Base buffer system
  - Respiratory Center
  - The Kidneys

Disorders of the Urinary System

Disorders of the Kidneys

- Many major illnesses can cause kidney disease
  - Diabetes, hypertension, and certain autoimmune diseases, can also cause serious kidney disease
  - Pyelonephritis: Infections of the kidneys
  - Kidney Stones
  - Retention of water and salt lead to edema
    - Can lead to heart failure

Acid-Base Balance

- Acid-Base Buffer Systems
  - Buffer – chemical or combination of chemicals
    - Can take up excess H\(^+\) or OH\(^-\)
    - Prevents large changes in pH
  - When H\(^+\) added to blood the following occurs
    \[ H^+ + HCO_3^- \rightarrow H_2CO_3 \]
  - When OH\(^-\) added to blood the following occurs
    \[ OH^- + H_2CO_3 \rightarrow HCO_3^- + H_2O \]
An Artificial Kidney Machine - Dialysis

Do we need to drink eight glasses of water each day?

Recently researchers have had success in growing entire human bladders in the lab, and implanting them into a limited number of patients.