URINARY SYSTEM
Urinary System

- General functions
  - Excretion
    - Excess water & solutes
    - Nitrogenous wastes
      - Ammonia ($NH_3$), uric acid, urea
  - Homeostasis
    - Water balance
    - Solute concentrations
      - $Na^+$, $K^+$, $Cl^-$
    - Blood pressure
## Water Input / Output

### WATER GAIN (milliliters)

<table>
<thead>
<tr>
<th></th>
<th>KANGAROO</th>
<th>RAT</th>
<th>HUMAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>by ingesting solids</td>
<td>6.0</td>
<td>0.0</td>
<td>850</td>
</tr>
<tr>
<td>by ingesting liquids</td>
<td>0.0</td>
<td>1,400</td>
<td>350</td>
</tr>
<tr>
<td>by metabolism</td>
<td>54.0</td>
<td>60.0</td>
<td>2,600</td>
</tr>
</tbody>
</table>

### WATER LOSS (milliliters)

<table>
<thead>
<tr>
<th></th>
<th>KANGAROO</th>
<th>RAT</th>
<th>HUMAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>in urine</td>
<td>13.5</td>
<td>2.6</td>
<td>1,500</td>
</tr>
<tr>
<td>in feces</td>
<td>43.9</td>
<td>60.0</td>
<td>200</td>
</tr>
<tr>
<td>by evaporation</td>
<td>900</td>
<td>2,600</td>
<td></td>
</tr>
</tbody>
</table>
Protein Metabolism

POOL OF CARBOHYDRATES AND FATS
(carbohydrates fats)

POOL OF AMINO ACIDS

structural components of cells
storage forms
specialized derivatives (e.g., steroids, acetylcholine)
used as cellular energy source

POOL OF AMINO ACIDS

nitrogen-containing derivatives (e.g., hormones, nucleotides)
components of structural proteins, enzymes

urea

urea

Food intake

dietary carbohydrates, lipids

dietary proteins, amino acids

NH₃

excreted as CO₂ via lungs
excreted in urine

some surface secretion, cell sloughing

cell activities

cell activities

some cell sloughing
Strategies for NH$_3$ Elimination

- **Dilution**
  - E.g., fish
  - NH$_3$ diffuses directly into surrounding water
  - Requires lots of water
Strategies for NH₃ Elimination

- **Insolubilization**
  - E.g., birds, reptiles
  - NH₃ converted to uric acid
    - Precipitates from solution
    - Little water required for excretion
Strategies for NH$_3$ Elimination

3 Detoxification

- E.g., mammals
- NH$_3$ converted to urea
  - Non-toxic
  - Excreted with water
Quick Quiz: Which of these is NOT a function of the urinary system?

A) Removing nitrogenous waste products from the body
B) Regulating water balance in the body
C) Eliminating undigested food waste from the body
D) Regulating blood pressure
Human Urinary System

- Structures
  - Kidneys
  - Ureters
  - Urinary bladder
  - Urethra
Kidney

- Structures
  - Renal arteries & veins
  - Renal cortex
  - Renal medulla
    - Medullary pyramids
  - Renal pelvis
Kidney

- **Structures**
  - Nephrons
    - Glomerulus
    - Loop of Henle
  - Vasa recta
Quick Quiz: The individual unit of the kidney is the…

A) nephron
B) glomerulus
C) urea
D) vasa recta
Kidney Function

- Filtration
- Reabsorption
- Secretion
- Excretion
“The Ultimate Garage Sale”

- **Filtration** ➔ Take out everything that fits through the door
- **Reabsorption** ➔ Bring back everything you want
- **Secretion** ➔ Take back out excess items
- **Excretion** ➔ Everything left goes
Reabsorption Efficiency

- ~2,000 L of blood flow through kidneys daily
  - “filters” blood supply ~400x/day
- Excrete ~1-2 L as urine daily
  - <0.1% of daily blood flow through kidneys excreted
Hormonal Regulation

- **Antidiuretic hormone (ADH)**
  - Released by…?
  - Promotes **reabsorption of water**

- **Aldosterone**
  - Released by…?
  - Promotes **reabsorption of Na⁺ (water follows)**
  - Stimulated by ACTH
Urine

- **Composition**
  - ~95% water
  - ~ 5% solutes
    - Urea
    - Na⁺
    - K⁺

- **Color**
  - Urochrome – pigment from rbc breakdown
Quick Quiz: Which of these processes is not done by a nephron during urine formation?

A) filtration
B) reabsorption
C) elimination
D) secretion