Mineral Requirements of Humans

Minerals are inorganic molecules required in small amounts. Often cofactors.

<table>
<thead>
<tr>
<th>Mineral</th>
<th>Major Dietary Sources</th>
<th>Some Major Functions in the Body</th>
<th>Possible Symptoms of Deficiency*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium (Ca)</td>
<td>Dairy products, dark green vegetables, legumes</td>
<td>Bone and tooth formation, blood clotting, nerves and muscle function</td>
<td>Rickets, osteoporosis, muscle cramps, nerve function</td>
</tr>
<tr>
<td>Phosphorus (P)</td>
<td>Dairy products, meats, grains</td>
<td>Bone and tooth formation, assist in nerve function</td>
<td>Weakness, loss of minerals from bones, weakness</td>
</tr>
<tr>
<td>Iron (Fe)</td>
<td>Meats, dairy products, nuts, beans, vegetables, grains</td>
<td>Component of hemoglobin, enzyme cofactor</td>
<td>Hemolytic anemia, fatigue, weakness</td>
</tr>
<tr>
<td>Iodine (I)</td>
<td>Seafood, eggs, legumes, grains</td>
<td>Component of hormones of the thyroid gland</td>
<td>Goiter, poor thyroid function</td>
</tr>
<tr>
<td>Magnesium (Mg)</td>
<td>Vegetables, whole grains</td>
<td>Component of enzymes, energy metabolism</td>
<td>Muscle cramps, poor muscle function</td>
</tr>
<tr>
<td>Zinc (Zn)</td>
<td>Meats, seafood, grains</td>
<td>Component of enzymes, energy metabolism</td>
<td>Poor wound healing, taste buds</td>
</tr>
<tr>
<td>Copper (Cu)</td>
<td>Seafood, nuts, legumes, organ meats</td>
<td>Component of enzymes, energy metabolism</td>
<td>Poor wound healing, poor immune system</td>
</tr>
<tr>
<td>Manganese (Mn)</td>
<td>Nuts, vegetables, fruits, tea</td>
<td>Component of enzymes, energy metabolism</td>
<td>Poor wound healing, poor immune system</td>
</tr>
<tr>
<td>Selenium (Se)</td>
<td>Seafood, dairy products, Brazil nuts</td>
<td>Component of enzymes, energy metabolism</td>
<td>Poor wound healing, poor immune system</td>
</tr>
<tr>
<td>Cobalt (Co)</td>
<td>Meat and dairy products</td>
<td>Component of enzymes, energy metabolism</td>
<td>Poor wound healing, poor immune system</td>
</tr>
<tr>
<td>Chromium (Cr)</td>
<td>Brewer’s yeast, tea, seaweed, nuts, some vegetables</td>
<td>Component of enzymes, energy metabolism</td>
<td>Poor wound healing, poor immune system</td>
</tr>
<tr>
<td>Molybdenum (Mo)</td>
<td>Legumes, grains, some vegetables</td>
<td>Component of enzymes, energy metabolism</td>
<td>Poor wound healing, poor immune system</td>
</tr>
</tbody>
</table>

Vitamin Requirements of Humans: Water-Soluble Vitamins

Vitamins are organic molecules required in small amounts. Often coenzymes.

<table>
<thead>
<tr>
<th>Vitamin</th>
<th>Major Dietary Sources</th>
<th>Some Major Functions in the Body</th>
<th>Possible Symptoms of Deficiency or Extreme Excess</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamin B1 (thiamine)</td>
<td>Pork, legumes, peanuts, whole grains</td>
<td>Converts pyruvate to acetyl-CoA, required for ATP synthesis</td>
<td>Beriberi (nerve disorder, confusion, anemia)</td>
</tr>
<tr>
<td>Vitamin B2 (riboflavin)</td>
<td>Dairy products, meats, enriched grains, vegetables</td>
<td>Converts pyruvate to acetyl-CoA, required for ATP synthesis</td>
<td>Severe fatigue, skin lesions, cataracts, sore mouth</td>
</tr>
<tr>
<td>Vitamin B6 (pyridoxine)</td>
<td>Meats, vegetables, whole grains</td>
<td>Converts pyruvate to acetyl-CoA, required for ATP synthesis</td>
<td>Severe fatigue, skin lesions, cataracts, sore mouth</td>
</tr>
<tr>
<td>Vitamin B12 (cobalamin)</td>
<td>Meats, eggs, dairy products</td>
<td>Converts pyruvate to acetyl-CoA, required for ATP synthesis</td>
<td>Severe fatigue, skin lesions, cataracts, sore mouth</td>
</tr>
<tr>
<td>Folic acid (folacin)</td>
<td>Green vegetables, oranges, peas, legumes, whole grains</td>
<td>Converts pyruvate to acetyl-CoA, required for ATP synthesis</td>
<td>Anemia, gastrointestinal problems, neural tube defects</td>
</tr>
<tr>
<td>Vitamin C (ascorbic acid)</td>
<td>Fruits and vegetables, dried fruits, broccoli, cabbage, tomatoes, green peppers</td>
<td>Converts pyruvate to acetyl-CoA, required for ATP synthesis</td>
<td>Scaly skin inflammation, scurvy (infected, weakened wounds)</td>
</tr>
</tbody>
</table>

*All of these minerals are essential for normal health.
Vitamin Requirements of Humans: Fat-Soluble Vitamins

<table>
<thead>
<tr>
<th>Vitamin</th>
<th>Major Dietary Sources</th>
<th>Some Major Functions in the Body</th>
<th>Possible Symptoms of Deficiency or Extreme Excess</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamin A</td>
<td>Provitamin A (beta-carotene) in deep green and orange</td>
<td>Component of visual pigment; needed for maintenance of</td>
<td>Vision problems, dry, scaling skin, headache,</td>
</tr>
<tr>
<td></td>
<td>vegetables and fruits; retinol in dairy products</td>
<td>cytochrome vision; antioxidant; helps prevent damage to</td>
<td>irritability, vomiting, hair loss, blurred vision,</td>
</tr>
<tr>
<td>Vitamin D</td>
<td>Dairy products, egg yolk (also made in human skin</td>
<td>Aids in absorption and use of calcium and phosphorus;</td>
<td>Rickets (bone deformities in children, bone</td>
</tr>
<tr>
<td></td>
<td>in presence of sunlight)</td>
<td>promotes bone growth</td>
<td>softening in adults)</td>
</tr>
<tr>
<td>Vitamin E</td>
<td>Vegetable oils, maa, seals</td>
<td>Antioxidant; helps prevent damage to lipids of cell</td>
<td>None well documented in humans; possibly anemia</td>
</tr>
<tr>
<td>Vitamin K</td>
<td>Green vegetables, tea (also made by colonic bacteria)</td>
<td>Important in blood clotting</td>
<td>Defects in blood clotting; bone damage and anemia</td>
</tr>
</tbody>
</table>

No need to memorize all of the vitamins and minerals, but do understand the general role that vitamins play in the body.
The human digestive system

From mouth to stomach: the swallowing reflex and esophageal peristalsis

Secretion of gastric juice

The duodenum
Enzymatic digestion in the human digestive system

### Oral cavity, pharynx, esophagus
- Carbohydrate digestion: Polysaccharides (starch, glycogen), Salivary amylase
- Small polysaccharides, maltose

### Stomach
- Protein digestion: Peptin, Small polypeptides

### Lumen of small intestine
- Polysaccharides: Pancreatic amylase, Maltase and other disaccharides
- Polypeptides: Trypsin, Chymotrypsin, Smaller polypeptides
- Aminopeptidase, Carboxypeptidase, Amino acids
- DNA, RNA, Nucleases, Nucleotides
- Fat globules: Bile salts, Fat droplets (emulsified), Lipase, Glycerol, fatty acids, glycerides

### Epithelium of small intestine (brush border)
- Disaccharides: Monosaccharides
- Small peptides: Dipeptides, Amino acids
- Nucleotidases: Nucleotides, Nucleosidases, Nitrogenous bases, sugars, phosphates

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Activation of protein-digesting enzymes in the small intestine

- Pancreas
- Inactive form
- Membrane-bound enteropeptidase
- Trypsinogen → Trypsin
- Procarboxypeptidase
- Chymotrypsinogen → Chymotrypsin
- Carboxypeptidase

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The structure of the small intestine

- Vein carrying blood to hepatic portal vessel
- Multi-layered epithelial cells
- Lumen
- Blood capillaries
- Lacteals
- Microvilli (brush border)

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Large intestine

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Dentition and diet

The digestive tracts of a carnivore (coyote) and a herbivore (koala) compared

Major things to know:

- Major compartments of the alimentary canal and their contributions to animal nutrition.

- Major digestive glands and their contributions to animal nutrition.

- How carbohydrates, fats, proteins and nucleic acids are digested.

Circulatory System

Circulates oxygen and other materials throughout the body.
Open and closed circulatory systems

The mammalian cardiovascular system: an overview

The mammalian heart: a closer look

The control of heart rhythm
The structure of blood vessels

Blood flow in veins

Direction of blood flow in vein (toward heart)

Valve (closed)
Skeletal muscle
Valve (open)

Blood flow in capillary beds

The movement of fluid between capillaries and the interstitial fluid
The composition of mammalian blood

- So you don't bleed to death when blood vessel is damaged
- Platelets plug up hole
- Reinforced by fibrin

Blood Clotting

Gas Exchange & Respiratory System

The role of gas exchange in bioenergetics
Diversity in the structure of gills, external body surfaces functioning in gas exchange

The structure and function of fish gills

Countercurrent exchange

Tracheal systems
The mammalian respiratory system

Negative pressure breathing

Rib cage expands as rib muscles contract
Rib cage gets smaller as rib muscles relax
Air inhaled
Air exhaled

Inhalation
Diaphragm contracts (moves down)
Exhalation
Diaphragm relaxes (moves up)

The avian respiratory system

Alveoli
Automatic control of breathing

Nerve impulses relay changes in CO₂ and O₂ concentrations

Oxygen dissociation curves for hemoglobin

Carbon dioxide transport in the blood: Bicarbonate-carbonic acid buffer
Major things to know:

- Circulatory vessels, heart chambers, path of mammalian circulation
- How red blood cells demonstrate the relationship of structure to function
- General characteristics of a respiratory surface
- Pathway of a molecule of oxygen through body

Excretory System

Nitrogenous wastes

Protonephridia: the flame-bulb system of a planarian
Metanephridia of an earthworm

Malpighian tubules of insects

The human excretory system at four size scales

Key functions of excretory systems: an overview
Major things to know:

- Three categories of nitrogen waste, which animal groups produce each and why

- The components of a nephron and what occurs in each region