Overview of Vitamins

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Overview of Vitamins

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Vitamins

- Tasteless, organic compounds
- Required in small amounts
- Functions
  - Regulate metabolism
  - Help convert energy in fat, carbohydrate, and protein into ATP
  - Promote growth and reproduction
- Deficiencies can result in potentially serious consequences
History of Vitamins

- Disease related to deficiency and foods that help were recognized long before the vitamin was discovered.

- Vitamins became valued for promoting public health.

- 1940s U.S. government mandated specific vitamins be added to grains and milk to improve health.

- Scientists are now focusing on prevention of disease with vitamin research.

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Naming Vitamins

- Each new vitamin is temporarily named when discovered

- The naming of vitamins follows the letters of the alphabet, starting with A; we are up to the letter K

  - A, B, C, D, E, and K

    - B has many subscripts

  - F, G, and H were dropped

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Criteria for Vitamins

- Cannot be synthesized in ample amounts in the body
- Chronic deficiency is likely to cause physical symptoms
- Symptoms will disappear once the vitamin level in the body is restored
  - Deficiency can cause permanent damage
- 13 compounds meet the above criteria
Classification of Vitamins

Classification is based on solubility

- Eight water-soluble: B vitamin complex and vitamin C
- Four fat-soluble: vitamins A, D, E, and K

- Solubility influences a vitamin’s
  - Digestion
  - Absorption
  - Transportation
  - Storage
  - Excretion
Vitamin Structure and Function

- All vitamins contain carbon, hydrogen, and oxygen
  - Some vitamins contain nitrogen and sulfur

- Chemical structure of each vitamin is unique

- Each vitamin is a singular unit

- Vitamins are absorbed intact

- Vitamins perform numerous essential functions

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Role of Vitamins in Promoting Health

**Metabolic functions**

- **Antioxidants**
  - Vitamin C & E

- **Blood clotting & red blood cell synthesis**
  - Folate, Vit B6, B12 & Vit K

- **Bone health**
  - Vit. A, D, K & C

- **Energy**
  - Biotin, Niacin, B1, B2, B6 & B12

- **Growth & Reproduction**
  - Vit A & D

- **Immune function**
  - Vit A, D & C

- **Protein metabolism**
  - Folate, B6 & B12

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Vitamin Absorption and Storage

- All absorption takes place in the small intestine

- Fat-soluble vitamins
  - Are absorbed in the duodenum
  - Storage
    - Vitamin A is mainly stored in the liver
    - Vitamins K and E are partially stored in the liver
    - Vitamin D is mainly stored in the fat and muscle tissue
    - Can build up in the body to the point of toxicity

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Vitamin Absorption and Storage

- Water-soluble vitamins
  - Absorbed with water and enter directly into the bloodstream
  - Most absorbed in the duodenum and jejunum
  - Most are not stored in the body
  - Excess intake excreted through the urine
  - Important to consume adequate amounts daily
  - Dietary excesses can be harmful

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Digesting and Absorbing Vitamins

**Digestion Process:**

- **a** Vitamins bound to proteins are released in the stomach.

- **b** In the small intestine, the fat-soluble vitamins are transported into the intestinal cells as part of micelles. Once inside the intestinal cells, fat-soluble vitamins are packaged with fat and other lipids into a chylomicron. The chylomicrons travel through the lymph system to the main circulation.

- **c** The water-soluble vitamins are absorbed directly into the portal vein from the small intestine.

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Figure 9.2
Digesting and Absorbing Water-Soluble Vitamins

- **a** Vitamins are hydrolyzed in the stomach from the protein complexes found in food.

- **b** Most of the water-soluble vitamins are absorbed in the upper small intestine with the exception of vitamin \( B_{12} \), which is absorbed in the ileum.

- **c** The water-soluble vitamins are absorbed directly into the portal vein and transported to the liver, where they are either stored \( (B_{12}) \) or sent out into circulation.

- **d** Excess water-soluble vitamins are excreted through the kidneys in the urine.

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Figure 10.1
<table>
<thead>
<tr>
<th>Water-Soluble Vitamins</th>
<th>Fat-Soluble Vitamins</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Absorbed in the</strong></td>
<td>Small Intestine</td>
</tr>
<tr>
<td><strong>Hydrophobic or</strong></td>
<td>Hydrophilic</td>
</tr>
<tr>
<td><strong>Hydrophilic</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Absorbed into the</strong></td>
<td>Blood</td>
</tr>
<tr>
<td><strong>Stored in the body</strong></td>
<td>Not Generally</td>
</tr>
<tr>
<td><strong>Can build up and</strong></td>
<td>Not Generally</td>
</tr>
<tr>
<td><strong>become toxic</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Need to consume</strong></td>
<td>Yes</td>
</tr>
<tr>
<td><strong>daily</strong></td>
<td></td>
</tr>
</tbody>
</table>

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Bioavailability

- Varies based on
  - Amount in food
  - Preparation
  - Efficiency of digestion and absorption of food
  - Individual nutritional status
  - Natural or synthetic
- Fat-soluble vitamins are generally less bioavailable than water-soluble vitamins
- Vitamins from animal foods are generally more bioavailable than those in plant foods

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Destruction of Vitamins

- Water-soluble vitamins can be destroyed by
  - Exposure to air
  - Exposure to ultraviolet light
  - Water
  - Changes in pH
  - Heat
  - Food preparation techniques

- Fat-soluble vitamins tend to be more stable
Toxicity with Overconsumption

- Vitamin toxicity, AKA hypervitaminosis
  - Rare
  - Results from ingesting excess vitamins and tissue saturation
  - Can damage cells

- Dietary Reference Intakes include tolerable upper intake limits (UL) for most vitamins to prevent excess
Antioxidants

- Group of compounds that neutralizes free radicals, helping to counteract the oxidation that takes place in cells

- Includes
  - Vitamins E
  - Vitamins C
  - Selenium
  - Flavonoids
  - Carotenoids
By-products of the body’s metabolic reactions

Normal reactions in the body, and stressors such as chemicals in the environment, smoking, and ultraviolet light create free radicals.

Free radicals have an unpaired electron that seeks an electron from another compound, causing a chain reaction of oxidation.

Free radicals lead to oxidative stress. This accelerates the aging process and increases the risk of heart disease, cancer, diabetes, arthritis, macular degeneration, Parkinson’s disease, and Alzheimer’s disease.

Antioxidants, such as vitamin E, neutralize free radicals by “lending” an electron to stabilize damaged atoms.
Antioxidants

These sources also act as antioxidants, stimulate the immune system and interact with hormones to prevent cancers.

- Phytochemicals
  - Carotenoids
  - Flavonoids

Get antioxidants and phytochemicals from the diet instead of supplements.

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Quick Review

- Antioxidants, such as vitamin E and C, selenium, flavonoids, and carotenoids, help counteract the damaging effects of free-radicals.
- Oxidative stress occurs when free radicals accumulate faster than the body can neutralize them.
  - Contribute to chronic disease and conditions.
- Fruits, vegetables, and whole grains are excellent sources of antioxidants.
Best Sources of Vitamins

- Whole foods
  - Fruits, vegetables, and whole grains
  - Rich in vitamins, phytochemicals, antioxidants, and fiber
- *Dietary Guidelines for Americans 2005*
  - Recommend a variety of foods
  - Increased fruits, vegetable, whole grains, and dairy recommendation
- Most people do not need supplements