Chapter 10

Water Soluble Vitamins: The B Vitamins and Vitamin C
Vitamins - Overview

- **Support nutritional health**
- **Structure** - vitamins are individual units
- **Function** -
  - do not provide energy
  - they assist the enzymes that release the energy from carbohydrate, fat, and protein
- **Food contents** - they are measured in micrograms or milligram rather than grams as in the macronutrients
Vitamins - Overview

**Bioavailability** - the rate and extent that a nutrient is absorbed and used.

It is based on:
- Efficiency of digestion and transit time
- Previous nutrient intake and nutrition status
- Other foods consumed at the same time
- Method of food preparation (raw, cooked, processed)
- Source of the nutrient (synthetic, fortified, natural)
The Vitamins--An Overview

- Precursors, also known as provitamins, are consumed in an inactive form and become active vitamins in the body.

- They are organic
  - They can be destroyed by exposure to light, oxidation, cooking, and storage.
The Vitamins--An Overview

**TABLE 10-1 Minimizing Nutrient Losses**

- To slow the degradation of vitamins, refrigerate (most) fruits and vegetables.
- To minimize the oxidation of vitamins, store fruits and vegetables that have been cut in airtight wrappers, and store juices that have been opened in closed containers (and refrigerate them).
- To prevent vitamin losses during washing, rinse fruits and vegetables before cutting (not after).
- To minimize vitamin losses during cooking, use a microwave oven or steam vegetables in a small amount of water. Add vegetables after water has come to a boil. Use the cooking water in mixed dishes such as casseroles and soups. Avoid high temperatures and long cooking times.
## The Vitamins Solubility

### TABLE 10-2 Water-Soluble and Fat-Soluble Vitamins Compared

<table>
<thead>
<tr>
<th></th>
<th>Water-Soluble Vitamins: B Vitamins and Vitamin C</th>
<th>Fat-Soluble Vitamins: Vitamins A, D, E, and K</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Absorption</strong></td>
<td>Directly into the blood</td>
<td>First into the lymph, then the blood</td>
</tr>
<tr>
<td><strong>Transport</strong></td>
<td>Travel freely</td>
<td>Many require transport proteins</td>
</tr>
<tr>
<td><strong>Storage</strong></td>
<td>Circulate freely in water-filled parts of the body</td>
<td>Stored in the cells associated with fat</td>
</tr>
<tr>
<td><strong>Excretion</strong></td>
<td>Kidneys detect and remove excess in urine</td>
<td>Less readily excreted; tend to remain in fat-storage sites</td>
</tr>
<tr>
<td><strong>Toxicity</strong></td>
<td>Possible to reach toxic levels when consumed from supplements</td>
<td>Likely to reach toxic levels when consumed from supplements</td>
</tr>
<tr>
<td><strong>Requirements</strong></td>
<td>Needed in frequent doses (perhaps 1 to 3 days)</td>
<td>Needed in periodic doses (perhaps weeks or even months)</td>
</tr>
</tbody>
</table>

*NOTE: Exceptions occur, but these differences between the water-soluble and fat-soluble vitamins are valid generalizations.*
Vitamins - Overview

Toxicity

- More is not better
- Tolerable upper intake levels have been established:
- The highest amount of a nutrient that is likely to not cause harm for most healthy people when consumed daily
Vitamins

Water Soluble
- B Vitamins
  - Thiamin
  - Riboflavin
  - Niacin
  - Pantothenic acid
  - Vitamin B6
  - Folate
  - Vitamin B12
- Vitamin C

Fat Soluble
- Vitamin A
- Vitamin D
- Vitamin E
- Vitamin K
The B Vitamins--As Individuals

- The B vitamins are very active in the body:
  - They do not provide fuel
  - Coenzymes that assist enzymes in the release of energy.
  - Other B Vitamins have roles in metabolism and cell replication

- There are deficiencies, toxicities and food sources that are unique for each vitamin.
Coenzyme Action

Without coenzymes, compounds A, B, and CD don't respond to their enzymes.

With the coenzymes in place, compounds are attracted to their sites on the enzymes.

... and the reactions proceed instantaneously. The coenzymes often donate or accept electrons, atoms, or groups of atoms.

The reactions are completed with either the formation of a new product, AB, or the breaking apart of a compound into two new products, C and D, and the release of energy.
NAD, NADP - niacin
TPP - thiamin
CoA - pantothenic acid
B12 - Vitamin B12
FAD, FMN - riboflavin
THF - folate
PLP - Vitamin B6
Biotin
Thiamin (Vitamin B₁)

**Thiamin Function:**
- Energy metabolism as part of the coenzyme thiamin pyrophosphate (TPP)
- Nerve cell activity and muscle activity

**Thiamin Recommendations**
- RDA Men: 1.2 mg/day
- RDA Women: 1.1 mg/day
Thiamin-B1

Deficiency:

- Most likely to occur in those with limited kcal intake
  - Homeless, malnourished
  - Alcoholics
    - Alcohol impairs thiamin absorption
    - Estimated 4 out of 5 alcoholics has thiamin deficiency (80%)
Thiamin (Vitamin B$_1$)

Thiamin Deficiency and Toxicity

- Deficiency results in the disease *beriberi*.
  - Wet beriberi affects cardiovascular system
    - presents with edema.
  - Dry beriberi affects the nervous system
    - presents with muscle wasting

- Symptoms include nervous system, heart and muscle damage, paralysis,

- No reported toxicities
Beri-Beri-Thiamin Deficiency

Figure 6-7. Swelling of the legs and pitting edema in ankles typical of “wet” beriberi as a result of vitamin B1 deficiency.
Pork is the richest source of thiamin, but enriched or whole-grain products typically make the greatest contribution to a day’s intake because of the quantities eaten. Legumes such as split peas are also valuable sources of thiamin.
Thiamin in Foods

Navy beans: 0.19 mg per 1/2 cup cooked
Sunflower seeds (shelled): 0.11 mg per 1/4 cup
Black beans: 0.21 mg per 1/2 cup cooked
Ham: 0.58 mg per 3 oz roasted
Pork chop: 0.76 mg per 3 oz broiled chop

RDA for men: 1.2 mg/day
RDA for women: 1.1 mg/day
Thiamin in Selected Foods

Many different foods contribute some thiamin, but few are rich sources. Together, several servings of a variety of nutritious foods will help meet thiamin needs. Bread and cereal selections should be either whole grain or enriched.
Riboflavin-B2

Function:
- Coenzyme FMN (flavin mononucleotide), FAD (flavin adenine dinucleotide) in energy metabolism
- Release of energy from nutrients

Recommendation:
- Men: 1.3 mg/day
- Women: 1.1 mg/day
Riboflavin (Vitamin B<sub>2</sub>)

- Riboflavin Deficiency and Toxicity
  - Deficiency disease is Ariboflavinosis
  - Deficiency Symptoms
    - Cracks and redness at the corners of the mouth - cheilosis
    - Painful, smooth and purplish red tongue - glossitis
    - Inflammation of the membranes of the mouth, skin, eyes, and gastrointestinal tract
  - No reported toxicities
A painful, inflamed tongue (glossitis) can signal a deficiency of niacin, vitamin B-6, riboflavin, folic acid, or vitamin B-12. Often more than one deficiency is the cause.
Riboflavin-B2

- **Food sources:**
  - Milk and milk products, whole grains, enriched cereals and grains, liver.
  - Destroyed by UV light
  - Stable in heat
Riboflavin in Foods

RDA for men: 1.3 mg/day
RDA for women: 1.1 mg/day

- Eggs: 0.25 mg per egg
- Whole wheat bread: 0.18 mg per slice
- Beef: 0.23 mg per 3 oz cooked
- Oysters: 0.38 mg per 3 oz cooked
- Clams: 0.36 mg per 3 oz canned
- Spinach: 0.11 mg per 1 cup raw
- Milk: 0.40 mg per cup
- Cottage cheese: 0.37 mg per cup
- Yogurt: 0.53 mg per cup
- Mushrooms: 0.23 mg per 1/2 cup cooked from fresh
# The B Vitamins – Riboflavin

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<th>Food</th>
<th>Serving size (kcalories)</th>
<th>Milligrams</th>
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</thead>
<tbody>
<tr>
<td>Bread, whole wheat</td>
<td>1 oz slice (70 kcal)</td>
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<td>Cornflakes, fortified</td>
<td>1 oz (110 kcal)</td>
<td></td>
</tr>
<tr>
<td>Spaghetti pasta</td>
<td>½ c cooked (99 kcal)</td>
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<tr>
<td>Tortilla, flour</td>
<td>1 10''-round (234 kcal)</td>
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<tr>
<td>Broccoli</td>
<td>½ c cooked (22 kcal)</td>
<td></td>
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<tr>
<td>Yogurt, plain</td>
<td>1 c low-fat (155 kcal)</td>
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<tr>
<td>Peanut butter</td>
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<td>1 oz dry (165 kcal)</td>
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<tr>
<td>Tofu (soybean curd)</td>
<td>½ c (76 kcal)</td>
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<tr>
<td>Ground beef, lean</td>
<td>3 oz broiled (244 kcal)</td>
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<td>Chicken breast</td>
<td>3 oz roasted (140 kcal)</td>
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<tr>
<td>Egg</td>
<td>1 hard cooked (78 kcal)</td>
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</tr>
</tbody>
</table>

**Excellent, and sometimes unusual, sources:**
- Liver: 3 oz fried (184 kcal)
- Clams, canned: 3 oz (126 kcal)
- Mushrooms: ½ c cooked (21 kcal)

**RIBOFLAVIN**
Milk and milk products (white) are noted for their riboflavin; several servings are needed to meet recommendations.

**Key:**
- Breads and cereals
- Vegetables
- Fruits
- Milk and milk products
- Legumes, nuts, seeds
- Meats
- Best sources per kcalorie
Niacin-B3
Nicotinic acid and Nicotinamide

Function:
- Coenzyme NAD (nicotinamide adenine dinucleotide), NADP
- Energy transfer reactions
  - Carries hydrogens from TCA cycle to electron transport chain
- Metabolism glucose, fat, alcohol
Niacin-B3
Nicotinic acid and Nicotinamide

Recommendations:

- Can make niacin from tryptophan (amino acid)
- Only occurs after protein synthesis needs have been met
- 60 mg tryptophan = 1 mg niacin
- Men: 16 NE/day (niacin equivalents)
- Women: 14 NE/day
- Upper level: 35 mg/day
Niacin (Vitamin B₃)

- Niacin Deficiency
  - A deficiency of niacin results in the disease Pellagra.

- Deficiency Symptoms:
  - Diarrhea, Dermatitis, Dementia, eventual Death ("the 4 D’s")
  - Diarrhea, abdominal pain, and vomiting
  - Dermatitis-Rash when exposed to sunlight
  - Dementia-depression, apathy, fatigue, loss of memory, and headache
  - Glossitis-Inflamed, swollen, smooth and bright red tongue
Pellagra
e. The dermatitis of a niacin deficiency and pellegra. Dermatitis on both sides of the body (bilateral) is a typical symptom. Sun exposure worsens the condition.
Niacin (Vitamin $B_3$)

- Niacin Toxicity
  - “Niacin flush” dilates the capillaries, causes a tingling sensation and may be painful.
  - Toxicity Symptoms with 3-4 X the RDA
    - Painful flush, hives and rash, tingling, burning
    - Headache, reddened face, arms, and chest
    - Excessive sweating
    - Liver damage
# Niacin in Selected Foods

Members of the meat group (red) are prominent niacin sources.

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<td>5</td>
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<td>0.12</td>
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Niacin in Foods

RDA for men: 16 mg/day    RDA for women: 14 mg/day

Turkey breast: 0.53 mg per 3 oz roasted
Peanut butter: 0.42 mg per 2 tablespoons
Tuna: 7.4 mg per 3 oz cooked from fresh
Sardines: 4.5 mg per 3 oz canned
Salmon: 5.7 mg per 3 oz baked
Whole wheat bread: 1.13 mg per slice
Mushrooms: 3.48 mg per 1/2 cup cooked from fresh
Asparagus: 0.97 mg per 6 spears cooked
Biotin

- **Function:**
  Coenzyme in metabolism that carries CO2
- **Recommendation:**
  Adequate intake: 30 UG/day
- **Deficiency:**
  Rare
  Raw egg whites bind with biotin and prevents absorption
- **Food sources:**
  Widespread, can also be synthesized by intestinal bacteria
Vitamin B6
Pyridoxal, Pyridoxine, Pyridoxamine

- **Function:**
  - Part of coenzyme PLP (pyridoxal phosphate)
  - **Active in amino acid metabolism**
  - Urea metabolism
  - Synthesis of non-essential amino acids,
  - Synthesis of heme, nucleic acids, lecithin
  - Conversion of tryptophan to niacin or serotonin.

- Stored exclusively in muscle tissue
Vitamin B6

- **Recommendation:**
  - 1.3 mg per day (Adults 19-50)

- **Deficiency:**
  - Anemia, depression, confusion, dermatitis
  - Advanced symptoms include - abnormal brain wave patterns, and convulsions
  - Alcohol-encourages loss of B6
  - INH-(TB Drug) binds with B6
Vitamin B6 - Pyridoxal, Pyridoxine, Pyridoxamine

**Toxicity:**
- Stored in muscle
- >2 grams >2 months
- Symptoms: depression, headache, fatigue, irreversible nerve damage, numbness, convulsions

**Sources:**
- Meat, fish, poultry, potatoes, bananas, watermelon, fortified cereals
Vitamin B6 in Foods

RDA for adults (19 to 50 yr.): 1.3 mg/day

Acorn squash: 0.24 mg per 1/2 cup mashed

Watermelon: 0.69 mg 1” by 10”: diameter piece

Turkey breast: 0.40 mg per 3 oz roasted

Beef: 0.38 mg per 3 oz cooked

Potato with skin: 0.7 mg per whole small potato

Banana: 0.66 per banana

Tuna: 0.39 mg per 3 oz cooked from fresh

Ham lunchmeat: 0.13 mg per slice

Sunflower seed (shelled): 0.28 mg per 1/4 cup
VITAMIN B₆

Many foods—including vegetables, fruits, and meats—offer vitamin B₆. Variety helps a person meet vitamin B₆ needs.

**Key:**
- Yellow: Breads and cereals
- Green: Vegetables
- Purple: Fruits
- White: Milk and milk products
- Brown: Legumes, nuts, seeds
- Red: Meats

**Excellent, and sometimes unusual, sources:**
- Prune juice ¾ c (137 kcal)
- Bluefish 3 oz baked (135 kcal)
- Squash, acorn ½ c baked (69 kcal)
Folate
Folacin, Folic Acid

*Function:*
- Coenzyme-THF-Tetrahydrofolate
- Transfers carbon compounds in metabolism
- Synthesis of DNA
- Converts B12 to its active form

*Recommendations:*
- 400 micrograms per day-Adults
- Synthetic folate in foods and supplements is more bioavailable
Folate’s Absorption and Activation

In foods, folate naturally occurs as polyglutamate. (Folate occurs as monoglutamate in fortified foods and supplements.)

In the intestine, digestion breaks glutamates off... and adds a methyl group. Folate is absorbed and delivered to cells.

In the cells, folate is trapped in its inactive form.

To activate folate, vitamin B₁₂ removes and keeps the methyl group, which activates vitamin B₁₂.

Both the folate coenzyme and the vitamin B₁₂ coenzyme are now active and available for DNA synthesis.
Folate
Folacin, Folic Acid

- Folate is critical in reducing the incidence of
  - Neural Tube Defects:
    - The brain and spinal cord develop from the neural tube
    - Defects in its formation early in pregnancy may result in neural tube defects such as spina bifida and anencephaly
  - Supplements of folate taken 1 month before and 1st three months of gestation can help prevent defects
  - 0.4 mg (400 micrograms) daily
Spina Bifida
Figure 10-11 p313

Folate

- Folate Deficiency
  - Deficiency Symptoms
    - Impairs cell division & protein synthesis
    - Macrocytic anemia, also called megaloblastic anemia – large cell type
    - G.I. tract deterioration-diarrhea
    - Smooth, red tongue
    - Mental confusion, weakness, fatigue, irritability and headaches
Normal Blood Cells & Blood Cells in Macrocytic Anemia Compared

**Normal red blood cell production**
- DNA synthesis and cell division begins
  - Hemoglobin synthesis begins
    - Hemoglobin synthesis intensifies, slowing DNA synthesis and cell division
    - Nucleus migrates to cell wall
      - Nucleus and all cell organelles leave the cell
    - Mature red blood cells are small, containing only cytoplasm packed with hemoglobin

**In folate (or vitamin B₁₂) deficiency**
- Without folate, DNA strands break and cell division diminishes
  - RNA synthesis continues, resulting in a large cell with a large nucleus
    - Red blood cells are relatively large (macrocytic), irregularly shaped, and often have a nucleus
Folate
Folacin, Folic Acid

- Enterohepatic circulation:
  - Excess is secreted in bile and reabsorbed
- Most vulnerable of all the vitamins to interactions with medications
  - Anticancer drugs
  - Antacids and aspirin
- Sources:
  - Legumes, vegetables, spinach, fortified grains
Folate in Foods
RDA for adults: 400*(micrograms)/day

- Broccoli: 90* per 1 spear cooked
- Orange juice: 75* per cup
- Legumes: 100* per 1/2 cup cooked
- Spinach: 109* per 1 cup raw
- Avocado: 113* per avocado
- Asparagus: 131* per 6 spears cooked
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**Excellent, and sometimes unusual, sources:**

- Lentils 1/2 c cooked (115 kcal)
- Asparagus 1/2 c cooked (22 kcal)
- Orange juice 1/4 c fresh (84 kcal)

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FOLATE
Vegetables (green) and legumes (brown) are rich sources of folate, as are fortified grain products (yellow).

**Key:**
- Breads and cereals
- Vegetables
- Fruits
- Milk and milk products
- Legumes, nuts, seeds
- Meats
- Best sources per kcalorie

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Cobalamin-B_{12}

- **Function:**
  - DNA, RNA Synthesis
  - Maintains myelin sheath that surrounds nerve fibers.
  - Bone cell activity and metabolism
  - Activates folate
  - Requires “intrinsic factor” in stomach for absorption
  - Secreted into bile and reabsorbed
Cobalamin - B\textsubscript{12}

- **Deficiency:**
  - Usually related to poor absorption, not poor intake
    - lack of intrinsic factor or hydrochloric acid
  - Can occur with *atrophic gastritis* (stomach cell damage)
    - decreases production of intrinsic factor
    - Lack of intrinsic factor = Pernicious Anemia
  - Leads to folate deficiency-anemia
  - Paralysis of nerves and muscles
    - B\textsubscript{12} protects the myelin sheath surrounding nerve fibers
  - **Vegan diet increases risk (may take up to 3 years)**
Normal blood cells. The size, shape, and color of these red blood cells show that they are normal.

Blood cells in pernicious anemia (megaloblastic). These megaloblastic blood cells are slightly larger than normal red blood cells, and their shapes are irregular.
Vitamin B12

**Recommendation:**
- 2.4 micrograms per day
- Enterohepatic circulation - most is reabsorbed

**Food Sources:**
- Animal products
  - meat, poultry, eggs, milk, dairy
- Destroyed by microwave heat
NAD, NADP - niacin
TPP - thiamin
CoA - pantothenic acid
B12 - Vitamin B12
FAD, FMN - riboflavin
THF - folate
PLP - Vitamin B6
Biotin
B Vitamin Deficiency Symptoms

A healthy tongue has a rough and somewhat bumpy surface.

In a B vitamin deficiency, the tongue becomes smooth and swollen due to atrophy of the tissue (glossitis).

In a B vitamin deficiency, the corners of the mouth become irritated and inflamed (cheilosis).
B12 deficiency
Vitamin C

Vitamin C Functions

- As an Antioxidant
  - Defends against free radicals
  - Protects tissues from oxidative stress and damage

- As a Cofactor in Collagen Formation
  - Collagen is used for bones and teeth, scar tissue, and artery walls.
  - Works with iron to form hydroxyproline which is needed in collagen formation
Vitamin C

- **Vitamin C Roles**
  - As a Cofactor in Other Reactions
    - Vitamin C needs increase during body stress, i.e. infections, burns, extremely high or low temperatures, heavy metal intakes, certain medications, and smoking.
  - As a Cure for the Common Cold
    - Conflicting research
    - At least 200 mg of Vitamin C daily decreases the duration of a cold
    - Vitamin C deactivates histamine like an antihistamine and decrease nasal congestion.
Vitamin C – Recommendations

- Prevent overt symptoms of scurvy
- Absorption maximum
  - 200 mg
- Higher vitamin C levels for smokers
Vitamin C

**Recommendations:**
- M-90mg  F-75mg
- May need extra in stress:
  - Infection, burns, high or low temp
  - Heavy metal intake
  - Aspirin
  - Oral contraceptives
- Cigarette smoking add 35 mg
Vitamin C

Vitamin C Deficiency
- Deficiency disease is called scurvy
- Deficiency Symptoms
  - Bleeding gums and loosened teeth
  - Capillaries under the skin break spontaneously (pinpoint hemorrhages)
  - Anemia – small cell type
  - Atherosclerotic plaques
  - Bone fragility and joint pain
  - Poor wound healing and frequent infections
  - Muscle degeneration and pain, hysteria, and depression
  - Rough, brown, scaly and dry skin and blotchy bruises
Vitamin C Deficiency

Scorbutic gums. Unlike other lesions of the mouth, scurvy presents a symmetrical appearance without infection.

Pinpoint hemorrhages. Small red spots appear in the skin, indicating spontaneous bleeding internally.
Vitamin C Deficiency
Scurvy

Pinpoint bleeding under the nails due to scurvy
Vitamin C

- Vitamin C Toxicity
  - Toxicity Symptoms
    - Nausea, abdominal cramps, diarrhea, headache, fatigue and insomnia
    - Hot flashes and rashes
    - Interference with medical tests, creating a false positive or a false negative
    - Aggravation of gout symptoms, urinary tract infections, and kidney stones
  - Upper level for adults: 2000 mg/day
Vitamin C

- Vitamin C Food Sources
  - Citrus fruits, cantaloupe, strawberries, papayas and mangoes
  - Cabbage-type vegetables, dark green vegetables like green peppers and broccoli, lettuce, tomatoes and potatoes

- Other Information
  - Also called ascorbic acid
  - Easily destroyed by heat and oxygen
Vitamin C in Foods

Orange: 70 mg per orange

Pink Grapefruit: 47 mg per 1/2 grapefruit

Grapefruit juice: 94 mg per cup

Orange juice: 124 mg per cup

Broccoli: 134 mg per 1 spear cooked

Brussels sprouts: 48 mg per 1/2 cup

Watermelon: 46 mg per 1” by 10” diameter piece

Kiwi: 74 mg per kiwi

Tomatoes: 23 mg per tomato

Yellow pepper: 342 mg per large pepper

Cantaloupe: 113 mg per 1/2 cantaloupe

Red pepper: 141 mg per pepper

Strawberries: 42 mg per 1/2 cup

RDA for adults: M-90 mg/day
F-75 mg/day
<table>
<thead>
<tr>
<th>Food</th>
<th>Serving size (kcalories)</th>
<th>Milligrams</th>
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<tbody>
<tr>
<td>Bread, whole wheat</td>
<td>1 oz slice (70 kcal)</td>
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<tr>
<td>Cornflakes, fortified</td>
<td>1 oz (110 kcal)</td>
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<tr>
<td>Spaghetti pasta</td>
<td>½ c cooked (99 kcal)</td>
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<tr>
<td>Tortilla, flour</td>
<td>1 10&quot;-round (234 kcal)</td>
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<tr>
<td>Broccoli</td>
<td>½ c cooked (22 kcal)</td>
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<tr>
<td>Carrots</td>
<td>½ c shredded raw (24 kcal)</td>
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<tr>
<td>Potato</td>
<td>1 medium baked w/skin (133 kcal)</td>
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</tr>
<tr>
<td>Tomato juice</td>
<td>¾ c (31 kcal)</td>
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</tr>
<tr>
<td>Banana</td>
<td>1 medium raw (109 kcal)</td>
<td></td>
</tr>
<tr>
<td>Orange</td>
<td>1 medium raw (62 kcal)</td>
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</tr>
<tr>
<td>Strawberries</td>
<td>½ c fresh (22 kcal)</td>
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</tr>
<tr>
<td>Watermelon</td>
<td>1 slice (92 kcal)</td>
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<tr>
<td>Milk</td>
<td>1 c reduced-fat 2% (121 kcal)</td>
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<tr>
<td>Yogurt, plain</td>
<td>1 c low-fat (155 kcal)</td>
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<tr>
<td>Cheddar cheese</td>
<td>1½ oz (171 kcal)</td>
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</tr>
<tr>
<td>Cottage cheese</td>
<td>½ c low-fat 2% (101 kcal)</td>
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<tr>
<td>Pinto beans</td>
<td>½ c cooked (117 kcal)</td>
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<tr>
<td>Peanut butter</td>
<td>2 tbs (188 kcal)</td>
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<tr>
<td>Sunflower seeds</td>
<td>1 oz dry (165 kcal)</td>
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<tr>
<td>Tofu (soybean curd)</td>
<td>½ c (76 kcal)</td>
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<tr>
<td>Ground beef, lean</td>
<td>3 oz broiled (244 kcal)</td>
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<tr>
<td>Chicken breast</td>
<td>3 oz roasted (140 kcal)</td>
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<tr>
<td>Tuna, canned in water</td>
<td>3 oz (99 kcal)</td>
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<tr>
<td>Egg</td>
<td>1 hard cooked (78 kcal)</td>
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</tr>
</tbody>
</table>

**Excellent, and sometimes unusual, sources:**

- Red bell pepper: ½ c raw chopped (20 kcal)
- Kiwi: 1 (46 kcal)
- Brussels sprouts: ½ c cooked (30 kcal)

**VITAMIN C**
Meeting vitamin C needs without fruits (purple) and vegetables (green) is almost impossible. Many of them provide the entire RDA in one serving, and others provide at least half. Most meats, legumes, breads, and milk products are poor sources.

**Key:**
- Yellow: Breads and cereals
- Green: Vegetables
- Purple: Fruits
- Brown: Milk and milk products
- Orange: Legumes, nuts, seeds
- Red: Meats
- Grey: Best sources per kcalorie

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End of Chapter 10
Water Soluble Vitamins
Highlight 10
Vitamin and Mineral Supplements
Vitamin/Mineral Supplements

When to use:
1. Correct overt deficiencies
2. Improve nutrition status
3. Reduce disease risk
4. Support increased needs
5. Improve bodies defenses
Vitamin/Mineral Supplements

Who should take them:
1. People with nutrient deficiencies
2. People eating <1600 Kcal
3. Vegans
4. Stages of life cycle
5. Decreased calcium intake, lactose intolerance
6. Inadequate sun
7. Diseases that interfere with digestion and absorption.
8. Medications that interfere with the bodies use of nutrients.
Arguments Against Supplements

- Toxicity
  - Supplement users are more likely to have excessive intakes
  - Issues with children
- Life-threatening misinformation
  - No guarantee of supplement effectiveness
- Unknown needs
  - “Ideal” supplements
- False sense of security
Selection of Supplements

- Follow directions carefully
- Single, balanced vitamin-mineral supplement
- U.S. Pharmacopeia (USP) logo
  - Logo assurances
- Two basic questions
  - Form
  - Contents
End of Chapter 10:
Water Soluble Vitamins