“Ashes to ashes, dust to dust” – when we die, what is left behind becomes nothing but a pile of ashes.

- Carbon atoms in carbohydrates, fats, proteins, and vitamins combine with oxygen to produce carbon dioxide, which goes into the air.
- Hydrogens and oxygens form water, and along with body water, this evaporates.
- Ashes are about 5 pounds of minerals.
Introduction – Water and Minerals

- About \( \frac{3}{4} \) is calcium and phosphorus
- Less than a teaspoon of iron
Introduction – Water and Minerals

- Calcium: 1,150 g
- Phosphorus: 600 g
- Potassium: 210 g
- Sulfur\(^a\): 150 g
- Sodium: 90 g
- Chloride\(^b\): 90 g
- Magnesium: 30 g
- Iron: 2.4 g
- Zinc: 2.0 g
- Copper: 0.09 g
- Iodine: 0.024 g

\(^a\)Sulfur is a nonmetallic, yellow element; sulfate, a compound of sulfur and oxygen, is required by the body for making sulfur-containing molecules.

\(^b\)Chlorine appears in the body as the chloride ion.
Introduction – Water and Minerals

- Major minerals – 7 minerals
  - Present in larger quantities than trace

- Trace minerals –
  - Present in smaller quantities than major
Water

Water is the most indispensable nutrient.

- Makes up about 60 percent of an adult’s weight.
- The brain is composed of about 80% water.

Water is the most indispensable nutrient.
Why Is Water the Most Indispensable Nutrient?

Water

- Carries nutrients throughout the body
- Serves as the solvent for chemicals in the body
- Cleanses the tissues and blood of wastes
- Participates in chemical reactions
- Acts as a lubricant around joints
- Serves as a shock absorber inside eyes, spinal cord, joints, and amniotic sac
- Aids in maintaining the body’s temperature
Human life begins in water
The Body’s Water Balance

To maintain water balance, a person must consume at least the same amount lost each day to avoid life-threatening losses.

A change in body’s water content can bring about a temporary change in body weight.

An extra drink of water benefits both young and old.
• The brain regulates water intake.
• When the blood pressure is too low, the hypothalamus sends nerve impulses to the brain that register as thirst.
• The more water the body needs the less it secrets.
• The hypothalamus signals to the pituitary gland to release a hormone that tells the kidneys to shift water back into the bloodstream.
Quenching Thirst and Balancing Losses

- Water comes in from foods, liquids, & metabolism
  
- Water leaves through evaporation of sweat, moisture of exhaled breath, urine, feces
## Quenching Thirst and Balancing Losses

### Table 8-1: Effects of Mild Dehydration, Severe Dehydration, and Chronic Lack of Fluid

<table>
<thead>
<tr>
<th>MILD DEHYDRATION</th>
<th>SEVERE DEHYDRATION</th>
<th>CHRONIC LOW FLUID INTAKE MAY INCREASE THE LIKELIHOOD OF:</th>
</tr>
</thead>
<tbody>
<tr>
<td>(LOSS OF &lt;5% BODY WEIGHT)</td>
<td>(LOSS OF &gt;5% BODY WEIGHT)</td>
<td>Bladder, colon, and other cancers</td>
</tr>
<tr>
<td>Thirst</td>
<td>Pale skin</td>
<td>Cardiac arrest (heart attack) and other heart problems</td>
</tr>
<tr>
<td>Sudden weight loss</td>
<td>Bluish lips and fingertips</td>
<td>Gallstones</td>
</tr>
<tr>
<td>Rough, dry skin</td>
<td>Confusion; disorientation</td>
<td>Kidney stones</td>
</tr>
<tr>
<td>Dry mouth, throat, body linings</td>
<td>Rapid, shallow breathing</td>
<td>Urinary tract infections</td>
</tr>
<tr>
<td>Rapid pulse</td>
<td>Weak, rapid, irregular pulse</td>
<td></td>
</tr>
<tr>
<td>Low blood pressure</td>
<td>Thickening of blood</td>
<td></td>
</tr>
<tr>
<td>Lack of energy; weakness</td>
<td>Shock; seizures</td>
<td></td>
</tr>
<tr>
<td>Impaired kidney function</td>
<td>Coma; death</td>
<td></td>
</tr>
<tr>
<td>Reduced quantity of urine; concentrated urine</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Decreased mental functioning</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Decreased muscular work and athletic performance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fever or increased internal temperature</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fainting</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Quenching Thirst and Balancing Losses

Thirst lags behind a lack of water
- To ignore thirst is to invite dehydration
  - When a person is thirsty, they may already have lost up to 2 cups of total fluid

Water intoxication occurs when too much plain water floods the body’s fluids and disturbs their normal composition
- Can occur if several gallons of water are consumed in a few hours’ time
  - Can be fatal
### Table 8-2: Factors That Increase Fluid Needs

These conditions increase a person's need for fluids:

- Alcohol consumption
- Cold weather
- Dietary fiber
- Diseases that disturb water balance, such as diabetes and kidney diseases
- Forced-air environments, such as airplanes and sealed buildings
- Heated environments
- High altitude
- Hot weather, high humidity
- Increased protein, salt, or sugar intakes
- Ketosis
- Medications (diuretics)
- Physical activity (see Chapter 10)
- Pregnancy and breastfeeding (see Chapter 13)
- Prolonged diarrhea, vomiting, or fever
- Surgery, blood loss, or burns
- Very young or old age
DRI recommends that

men: 13 cups
women: 9 cups

from beverages and drinking water which accounts for 80% of water needs

20% comes from foods
• Water makes up at least 95% of the volume of fruits and vegetables and at least 50% meats and cheeses
<table>
<thead>
<tr>
<th>Hard water</th>
<th>Soft water</th>
</tr>
</thead>
<tbody>
<tr>
<td>high concentrations of calcium and magnesium</td>
<td>High in sodium</td>
</tr>
<tr>
<td>Leaves a ring on the tub</td>
<td>it dissolves cadmium and lead from pipes</td>
</tr>
<tr>
<td>Calcium protects the absorption of lead in the body</td>
<td>Makes more bubbles with less soap</td>
</tr>
<tr>
<td></td>
<td>May aggravate hypertension and heart disease</td>
</tr>
</tbody>
</table>
Water is practically a universal solvent: it dissolves almost anything it encounters to some degree.

- Hundreds of contaminants have been detected in public drinking water
The Environmental Protection Agency (EPA) is responsible for ensuring that public water systems meet minimum standards for protection of health.

Public water systems remove some hazards; treatment includes the addition of a disinfectant (usually chlorine) to kill most microorganisms.
Safety of Public Water

- Some research shows that chlorine in water has caused cancer in laboratory animals.
- Causes cancer related changes in human cells.
- 25,000 people die daily in parts of the world where water is not treated with chlorine.
All drinking water originates from surface water or ground water that is vulnerable to contamination from human activities.

<table>
<thead>
<tr>
<th>Table</th>
<th>Water Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>8-4</td>
<td></td>
</tr>
<tr>
<td>• aquifers</td>
<td>underground rock formations containing water that can be drawn to the surface for use.</td>
</tr>
<tr>
<td>• groundwater</td>
<td>water that comes from underground aquifers.</td>
</tr>
<tr>
<td>• surface water</td>
<td>water that comes from lakes, rivers, and reservoirs.</td>
</tr>
</tbody>
</table>
Consumer Corner: Bottled Water

- About 1 in 15 households uses bottled water as its main drinking water source.
- Costs about 250 to 10,000 times the price of tap water.
- A consumer group tested bottled water, however, and disproved the notion of superior safety.
  - About 1/3 were contaminated with bacteria, arsenic, or synthetic organic chemicals.
Consumer Corner: Bottled Water

The label on a water bottle may imply purity but what counts is the purity of the product inside.
## Consumer Corner: Bottled Water

### Table 8-4: Water Terms That May Appear on Labels

- **artesian water**: water drawn from a well that taps a confined aquifer in which the water is under pressure.
- **baby water**: ordinary bottled water treated with ozone to make it safe but not sterile.
- **caffeine water**: bottled water with caffeine added.
- **carbonated water**: water that contains carbon dioxide gas, either naturally occurring or added, that causes bubbles to form in it; also called *bubbling or sparkling water*. Seltzer, soda, and tonic waters are legally soft drinks and are not regulated as water.
- **distilled water**: water that has been vaporized and recondensed, leaving it free of dissolved minerals.
- **filtered water**: water treated by filtration, usually through activated carbon filters that reduce the lead in tap water, or by reverse osmosis units that force pressurized water across a membrane removing lead, arsenic, and some microorganisms from tap water.
- **fitness water**: lightly flavored bottled water enhanced with vitamins, supposedly to enhance athletic performance (see Chapter 10's Consumer Corner).
- **mineral water**: water from a spring or well that typically contains 250 to 500 parts per million (ppm) of minerals. Minerals give water a distinctive flavor. Many mineral waters are high in sodium.
- **natural water**: water obtained from a spring or well that is certified to be safe and sanitary. The mineral content may not be changed, but the water may be treated in other ways such as with ozone or by filtration.
- **public water**: water from a municipal or county water system that has been treated and disinfected.
- **purified water**: water that has been treated by distillation or other physical or chemical processes that remove dissolved solids. Because purified water contains no minerals or contaminants, it is useful for medical and research purposes.
- **spring water**: water originating from an underground spring or well. It may be bubbly (carbonated) or “flat” or “still,” meaning not carbonated. Brand names such as “Spring Pure” do not necessarily mean that the water comes from a spring.
- **vitamin water**: bottled water with a few vitamins added; does not replace vitamins from a balanced diet and may worsen overload in people receiving vitamins from enriched food, supplements, and other enriched products such as “energy” bars.
- **well water**: water drawn from groundwater by tapping into an aquifer.
Consumer Corner: Bottled Water

- Bottled water is unpredictable in its content of fluoride, a mineral important to the health of teeth and bones.
- Vitamin-fortified bottled waters are simply liquid supplements.
Body Fluids and Minerals

- Most water is inside the cell.
- Some water is on the outside of the cells.
- The rest is in the blood vessels.
Question

How do cells keep themselves from collapsing when water leaves them and from swelling up when too much water enters them?
Water Follows Salt

- Cells can't control the amount of water by pumping it in and out directly.
- Cells can pump minerals across their membranes.
Major minerals form **salts** that dissolve in body fluids; the cells direct where the salts go; and this determines where the fluids flow because water follows salt.

The slices of eggplant on the right were sprinkled with salt. Notice their beads of “sweat,” formed as cellular water moves across each cell’s membrane (water-permeable divider) toward the higher concentration of salt (dissolved particles) on the surface.
Fluid and Electrolyte Balance

- When minerals or other salts dissolve in water they become ions.

- Ions: single, electronically charged particles
  - sodium have a (+) charge
  - chloride has (-) charge

- Ions that dissolve in water are called electrolytes b/c they carry an electrical current

- Water helps keep the fluid and electrolyte balance by moving in the direction of highly concentrated solution

- A healthy body must have the proper amount and kind of fluid in every body compartment
• Water and minerals lost in vomiting or diarrhea come from every body cell.

• This will disrupt the heartbeat and threaten life

• People with eating disorders can die from this.
Fluid and Electrolyte Balance

1. With equal numbers of dissolved particles on both sides of a water-permeable divider, water levels remain equal.

2. Now additional particles are added to increase the concentration on side B. Particles cannot flow across the divider (in the case of fluid inside and outside a cell, the divider is a cell membrane).

3. Water can flow both ways across the divider but tends to move from side A to side B, where there is a greater concentration of dissolved particles. The volume of water increases on side B, and the concentrations on sides A and B become equal.
Acid-Base Balance

Minerals help manage the **acid-base balance**, or **pH**.

Acid-base balance: having the right amount of acidity in each of the body's fluids.

The body’s proteins and some of its mineral salts act as **buffers** – molecules that keeps a tight control on pH.

The body needs to maintain the proper pH balance in order to function and stay alive.
The Major Minerals

- Calcium
- Chloride
- Magnesium
- Phosphorus
- Potassium
- Sodium
- Sulfate
Nearly all (99%) of the body’s calcium is stored in the bones and teeth.

Two important roles:

- Integral part of bone structure
- Serves as a bank that can release calcium to the body fluids if the slightest drop in blood concentration occurs
Calcium

Bone is active, living tissue. Blood travels in capillaries throughout the bone, bringing nutrients to the cells that maintain the bone's structure and carrying away waste materials from those cells. It picks up and deposits minerals as instructed by hormones.

Bone derives its structural strength from the lacy network of crystals that lie along its lines of stress. If minerals are withdrawn to cover deficits elsewhere in the body, the bone will grow weak and ultimately will bend or crumble.
Only about 1 percent of the body’s calcium is in the fluids that bathe and fill the cells, but this tiny amount plays these major roles:

- Regulates the transport of ions
- Helps maintain blood pressure
- Plays a role in blood clotting
- Essential for muscle contraction
- Allows for secretion of hormones, digestive enzymes, and neurotransmitters
- Activates cellular enzymes
**Calcium and the Bones**

- Skeleton is a bank from which the blood can borrow and return calcium as needed.
- If more calcium is needed in the body, the body can increase the absorption from the intestine and prevent its loss from the kidneys.
Bone loss is an inevitable consequence of aging.

Sometime around age 30, or 10 years after adult height is achieved, the skeleton no longer adds to bone density.

After about age 40, bones begin to lose calcium but the loss can be slowed somewhat by diet and regular physical activity.
**Osteoporosis**, or **adult bone loss**, occurs if a person’s calcium savings bank is not sufficient.

A diet low in calcium-rich foods during the growing years may prevent person from achieving **peak bone mass**.
Calcium and the Bones

- Active growth
- Peak bone mass
- Bone loss

Time (years)
Bone density

10 20 30 40 50 60 70 80
Obtaining enough calcium in childhood helps ensure that the skeleton starts adulthood with a high bone density.
How Much Calcium Do I Need?

**SNAPSHOT 8.1**

**CALCIUM**

**DRI RECOMMENDED INTAKES:**
- Adults: 1,000 mg/day (19–50 yr)
- 1,200 mg/day (>51 yr)

**TOLERABLE UPPER INTAKE LEVEL:**
- Adults: 2,500 mg/day

**CHIEF FUNCTIONS:**
- Mineralization of bones and teeth;
- Muscle contraction and relaxation;
- Nerve functioning; blood clotting

**DEFICIENCY:**
- Stunted growth and weak bones in children;
- Bone loss (osteoporosis) in adults

**TOXICITY:**
- Constipation; interference with absorption of other minerals; increased risk of kidney stone formation

*These foods provide 10 percent or more of the calcium Daily Value in a serving. For a 2,000-calorie diet, the DV is 1,000 mg/day.

*Although broccoli, kale, and some other cooked green leafy vegetables fall short of supplying 10 percent of calcium in a serving, these foods are important sources of bioavailable calcium. Almonds also supply calcium. Other greens, such as spinach and chard, contain calcium in an unabsorbable form. Note that the amounts for green vegetables exceed 1/2 c serving of the USDA Food Guide. Some calcium-rich mineral waters may also be good sources.

**GOOD SOURCES**

- **SARDINES** (with bones)
  - 3 oz = 324 mg

- **CHEDDAR CHEESE**
  - 1/2 oz = 306 mg

- **MILK**
  - 1 c = 300 mg

- **TURNIP GREENS** (cooked)
  - 1 c = 197 mg

- **TOFU** (calcium set)
  - 1/2 c = 275 mg

- **WAFFLE** (whole grain)
  - 1 WAFFLE = 196 mg

- **BLACK-EYED PEAS** (cooked)
  - 1/2 c = 105 mg

- **BROCCOLI** (cooked)
  - 1/2 c = 93 mg
Phosphorus

- Second most abundant mineral in the body
- 85% of body’s phosphorus is found combined with calcium in the bones and teeth

- Phosphorus also:
  - Helps maintain acid-base balance
  - Part of genetic material
  - Assists in energy metabolism
  - Forms part of cell membranes
**Phosphorus**

**DRI RECOMMENDED INTAKE:**
Adults: 700 mg/day

**TOLERABLE UPPER INTAKE LEVEL:**
Adults (19–70 yr): 4,000 mg/day

**CHIEF FUNCTIONS:**
Mineralization of bones and teeth; part of phospholipids, important in genetic material, energy metabolism, and buffering systems

**DEFICIENCY:**
Muscular weakness, bone pain

**TOXICITY:**
Calcification of soft tissues, particularly the kidneys

*These foods provide 10 percent or more of the phosphorus Daily Value in a serving. For a 2,000-calorie diet, the DV is 1,000 mg/day.

*Dietary deficiency rarely occurs, but some drugs can bind with phosphorus making it unavailable.

**GOOD SOURCES**

- **COTTAGE CHEESE**
  1 c = 341 mg

- **MILK**
  1 c = 235 mg

- **SALMON (canned)**
  3 oz = 280 mg

- **SIRLOIN STEAK (lean)**
  3 oz = 208 mg

- **NAVY BEANS (cooked)**
  1/2 c = 143 mg
Magnesium

A major mineral and yet there is only about 1 ounce in a 130-pound person, over half in the bones.

Most of the body’s magnesium is in the bones and can be drawn out for all the cells to use in building protein and using the energy nutrients.
SNAPSHOT 8-3

**MAGNESIUM**

**DRI RECOMMENDED INTAKES:**
Men (19–30 yr): 400 mg/day
Women (19–30 yr): 310 mg/day

**TOLERABLE UPPER INTAKE LEVEL:**
Adults: 350 mg/day

**CHIEF FUNCTIONS:**
Bone mineralization, protein synthesis, enzyme action, muscle contraction, nerve function, tooth maintenance, and immune function

**DEFICIENCY:**
Weakness, confusion; if extreme, convulsions, uncontrollable muscle contractions, hallucinations, and difficulty in swallowing; in children, growth failure

**TOXICITY:**
From nonfood sources only; diarrhea, pH imbalance, dehydration

*These foods provide 10 percent or more of the magnesium Daily Value in a serving. For a 2,000-calorie diet, the DV is 400 mg/day.

*aFrom nonfood sources, in addition to the magnesium provided by food.

*bWheat bran provides magnesium, but refined grain products are low in magnesium.

*Magnesium in oysters varies.

**GOOD SOURCES**

- Spinach (cooked): ½ c = 78 mg
- Black beans (cooked): ½ c = 60 mg
- Soy milk: 1 c = 46 mg
- Black-eyed peas (cooked): ½ c = 44 mg
- Bran cereal: 1 c (ready-to-eat) = 60 mg
- Oysters: 3 oz = 81 mg
- Yogurt (plain): 1 c = 43 mg
Salt has been valued throughout recorded history.

- “You are the salt of the earth” means you are valuable.

Even the word *salary* comes from the Latin word for salt.
Sodium is the main positively charged ion outside the body’s cells.

In 1 gram of table salt, NaCl, there are 400 milligrams of sodium and 600 milligrams of chloride.

Sodium

- Is a major part of the body’s fluid and electrolyte balance system.
- Helps maintain acid-base balance.
- Is essential to muscle contraction and nerve transmission.
30 to 40 percent of body’s sodium is on the surface of the bone crystals where it is easily drawn upon to replenish blood concentrations.

Why are people urged to limit sodium?

- To understand why, you must first understand how sodium interacts with body fluids.
If blood sodium rises, as it will after a person eats salted foods, thirst ensures that the person will drink water until the sodium-to-water ratio is restored. Then the kidneys excrete the extra water along with the sodium.

Overly strict use of low-sodium diets can deplete the body of needed sodium; so can vomiting, diarrhea, or very heavy sweating.
### Sodium Intakes

**TABLE 8-5 Sodium and Salt Intake Guidelines**

#### DRI Recommendations
- **Recommended intakes for sodium:**
  - Adults (19–50 years): 1,500 mg per day.
  - Adults (51–70 years): 1,300 mg per day.
  - Adults (71 years and older): 1,200 mg per day.
- **Tolerable Upper Intake Level for sodium and salt:**
  - Adults (19 years and older): 2,300 mg sodium, or 5.6 g salt (sodium chloride) per day.

*The Dietary Guidelines for Americans 2005 Key Recommendations:*
- Consume less than 2,300 mg of sodium (approximately 1 tsp salt) per day.
- Choose and prepare foods with little salt.
- **People with hypertension, blacks, and middle-aged and older adults:**
  - Aim to consume no more than 1,500 mg of sodium per day, and meet the potassium recommendation of 4,700 mg/day from food sources.
The relationship between salt intakes and blood pressure is direct – the more salt a person eats, the higher the blood pressure goes.

- Stronger effect among people with diabetes, hypertension, kidney disease, African descent, history of parents with hypertension, and anyone over 50 years of age.

- Higher blood pressure is related to heart disease and strokes.
The DASH (Dietary Approaches to Stop Hypertension) diet often achieves a lower blood pressure than restriction of sodium alone.

- Calls for greatly increased intakes of fruits and vegetables, with adequate amounts of nuts, fish, whole grains, and low-fat dairy products.

- Only small amounts of red meat, butter, and other high-fat foods, and sweets are held to occasional small portions.

- Salt and sodium are greatly reduced.
Low potassium intake on its own raises blood pressure, whereas high potassium intake appears to both help prevent and correct hypertension.
TABLE 8-6 How to Cut Sodium from a Barbecue Lunch

Lunch #1 exceeds the whole day’s Tolerable Upper Intake Level of 2,300 milligrams sodium. With careful substitutions, the sodium drops dramatically in the second lunch, but it still provides over 40 percent of the suggested maximum intake. In lunch #3, just two small changes—omitting the sauce and salt—cut the sodium by half again.

<table>
<thead>
<tr>
<th>LUNCH #1: HIGHEST</th>
<th>SODIUM (MG)</th>
<th>LUNCH #2: LOWER</th>
<th>SODIUM (MG)</th>
<th>LUNCH #3: LOWEST</th>
<th>SODIUM (MG)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chopped pork sandwich, with sauce</td>
<td>950</td>
<td>Sliced pork sandwich, with 1 tbs sauce</td>
<td>400</td>
<td>Sliced pork sandwich (no sauce)</td>
<td>210</td>
</tr>
<tr>
<td>Creamed corn, 1/2 c</td>
<td>460</td>
<td>Corn, 1 cob, soft margarine, salt</td>
<td>190</td>
<td>Corn, 1 cob, soft margarine</td>
<td>50</td>
</tr>
<tr>
<td>Potato chips, 2.5 oz</td>
<td>340</td>
<td>Coleslaw, 1/2 c</td>
<td>180</td>
<td>Green salad, oil and vinegar</td>
<td>10</td>
</tr>
<tr>
<td>Dill pickle, 1/2 medium</td>
<td>420</td>
<td>Watermelon, slice</td>
<td>10</td>
<td>Watermelon, slice</td>
<td>10</td>
</tr>
<tr>
<td>Milk, low-fat, 1 c</td>
<td>120</td>
<td>Milk, reduced-fat, 1 c</td>
<td>120</td>
<td>Milk, reduced-fat, 1 c</td>
<td>120</td>
</tr>
<tr>
<td>Pecan pie, slice</td>
<td>480</td>
<td>Ice cream, low-fat, 1/2 c</td>
<td>80</td>
<td>Ice cream, low-fat, 1/2 cup</td>
<td>80</td>
</tr>
<tr>
<td><strong>Total</strong> 2,770</td>
<td></td>
<td><strong>Total</strong> 980</td>
<td></td>
<td><strong>Total</strong> 480</td>
<td></td>
</tr>
</tbody>
</table>
## Controlling Salt Intake

### Unprocessed Foods

Those that are low in sodium contribute less than 10 percent of the total sodium in the U.S. diet.

<table>
<thead>
<tr>
<th>Food Item</th>
<th>Sodium Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk, 120 mg per 1 c</td>
<td></td>
</tr>
<tr>
<td>Scallops, 260 mg per 3 oz</td>
<td></td>
</tr>
<tr>
<td>Fresh meats, about 30 to 70 mg per 3 oz</td>
<td></td>
</tr>
<tr>
<td>Chicken, beef, fish, lamb, pork</td>
<td></td>
</tr>
<tr>
<td>Fresh vegetables, about 30 to 50 mg per 1/2 c</td>
<td></td>
</tr>
<tr>
<td>Celery, Chinese cabbage, sweet potatoes</td>
<td></td>
</tr>
<tr>
<td>Fresh vegetables, about 10 to 20 mg per 1/2 c</td>
<td></td>
</tr>
<tr>
<td>Broccoli, brussels sprouts, carrots, corn, green beans, legumes, potatoes, salad greens</td>
<td></td>
</tr>
<tr>
<td>Grains (cooked without salt), about 0 to 10 mg per 1/2 c</td>
<td></td>
</tr>
<tr>
<td>Barley, oatmeal, pasta, rice</td>
<td></td>
</tr>
</tbody>
</table>

### Salt

Salt added at home, in cooking or at the table, contributes 15 percent of the total sodium in the U.S. diet. Many seasonings and sauces also contribute salt and sodium.

<table>
<thead>
<tr>
<th>Seasonings and Sauces</th>
<th>Sodium Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barbecue sauce, ketchup, mustard</td>
<td></td>
</tr>
<tr>
<td>Salad dressings, sweet pickle relish</td>
<td></td>
</tr>
<tr>
<td>Taco sauce, Worcester sauce</td>
<td></td>
</tr>
</tbody>
</table>

### Processed Foods

These contribute 75 percent of the sodium in the U.S. diet.

<table>
<thead>
<tr>
<th>Food Item</th>
<th>Sodium Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry soup mixes (prepared), about 1,000 to 2,000 mg per 1 c</td>
<td></td>
</tr>
<tr>
<td>Bouillon cube or canned, noodle soups, onion soup, ravioli</td>
<td></td>
</tr>
<tr>
<td>Smoked and cured meats, about 700 to 2,000 mg per 2 oz</td>
<td></td>
</tr>
<tr>
<td>Canned ham products, corned or chipped beef, ham, lunchmeats</td>
<td></td>
</tr>
<tr>
<td>Fast foods and TV dinners, about 700 to 1,500 mg per serving</td>
<td></td>
</tr>
<tr>
<td>Breakfast biscuit (cheese, egg, and ham), cheeseburger, chicken wings (10 spicy wings), frozen TV dinners, pizza (2 slices), taco, vegetarian soy burger (on bun)</td>
<td></td>
</tr>
<tr>
<td>Canned soups (prepared), about 700 to 1,500 mg per 1 c</td>
<td></td>
</tr>
<tr>
<td>Barley soup, beef or chicken soups, &quot;hearty&quot; soups, tomato soup, vegetable soup</td>
<td></td>
</tr>
<tr>
<td>Canned pasta, about 800 to 1,000 mg per serving</td>
<td></td>
</tr>
<tr>
<td>Beefaroni, macaroni and cheese, ravioli</td>
<td></td>
</tr>
<tr>
<td>Hot dogs, about 500 to 700 mg per 2 oz</td>
<td></td>
</tr>
<tr>
<td>Hot dogs, smoked sausages</td>
<td></td>
</tr>
<tr>
<td>Foods prepared in brine, about 300 to 800 mg per serving</td>
<td></td>
</tr>
<tr>
<td>Anchovies (2 filets), dill pickles (1), olives (5), sauerkraut 1/2 c</td>
<td></td>
</tr>
<tr>
<td>Cheeses, processed, about 550 mg per 1 1/2 oz</td>
<td></td>
</tr>
<tr>
<td>American, cheddar, Swiss</td>
<td></td>
</tr>
<tr>
<td>Pudding, instant, about 420 mg per 1/2 c</td>
<td></td>
</tr>
<tr>
<td>All flavors</td>
<td></td>
</tr>
<tr>
<td>Canned vegetables, about 200 to 450 mg per 1/2 c</td>
<td></td>
</tr>
<tr>
<td>Carrots, corn, green beans, legumes, peas, potatoes</td>
<td></td>
</tr>
<tr>
<td>Cereals, dry ready-to-eat, about 180 to 260 mg per 1 oz</td>
<td></td>
</tr>
<tr>
<td>Cheerios, cornflakes, corn bran, Cocoa Puffs, Total, others</td>
<td></td>
</tr>
</tbody>
</table>

*Note that herb seasoning blends may or may not contain substantial sodium; read the labels.*
Potassium

Potassium is the principal positively charged ion inside the body’s cells.

Plays a major role in maintaining fluid and electrolyte balance and cell integrity, and is critical in maintaining a heartbeat.
Potassium

**DRI RECOMMENDED INTAKE:**
Adults: 4,700 mg/day

**CHIEF FUNCTIONS:**
Maintains normal fluid and electrolyte balance; facilitates chemical reactions; supports cell integrity; assists in nerve functioning and muscle contractions

**DEFICIENCY:**
Muscle weakness, paralysis, confusion

**TOXICITY:**
Muscle weakness; vomiting; for an infant given supplements, or when injected into a vein in an adult, potassium can stop the heart

*These foods provide 10 percent or more of the potassium Daily Value in a serving. For a 2,000-calorie diet, the DV is 3,500 mg/day.

*aDeficiency accompanies dehydration.

**GOOD SOURCES**

- **SALMON (cooked)**
  - 4 oz = 437 mg

- **BAKED POTATO**
  - whole potato = 844 mg

- **ORANGE JUICE**
  - 1 c = 496 mg

- **BANANA**
  - 1 whole banana = 422 mg

- **HONEYDEW MELON**
  - 1 cup = 427 mg

- **LIMA BEANS (cooked)**
  - ½ c = 486 mg

- **AVOCADO**
  - ⅓ c avocado = 372 mg
Chloride

Chloride is the body’s major negative ion; it is responsible for stomach acidity and assists in maintaining body chemistry.

No known diet lacks chloride.
Sulfate

- Sulfate is the oxidized form of sulfur as it exists in food and water.
- Used to synthesize sulfur-containing body compounds.
The Trace Minerals

- Often difficult to determine their precise roles in humans due to the difficulty of providing an experimental diet lacking in the one element under study.

- Studies are generally done in laboratory animals which can be fed highly defined diets.
# The Trace Minerals

<table>
<thead>
<tr>
<th>HUMAN INTAKE RECOMMENDATIONS ESTABLISHED</th>
<th>KNOWN ESSENTIAL FOR ANIMALS; HUMAN REQUIREMENTS UNDER STUDY</th>
<th>KNOWN ESSENTIAL FOR SOME ANIMALS; NO EVIDENCE THAT INTAKE BY HUMANS IS EVER LIMITING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iodine</td>
<td>Arsenic</td>
<td>Cobalt</td>
</tr>
<tr>
<td>Iron</td>
<td>Boron</td>
<td></td>
</tr>
<tr>
<td>Zinc</td>
<td>Nickel</td>
<td></td>
</tr>
<tr>
<td>Selenium</td>
<td>Silicon</td>
<td></td>
</tr>
<tr>
<td>Fluoride</td>
<td>Vanadium</td>
<td></td>
</tr>
<tr>
<td>Chromium</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Copper</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manganese</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Molybdenum</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: The evidence for requirements and essentiality is weak for the trace minerals cadmium, lead, lithium, and tin.
Iodine is part of thyroxine, the hormone made by the thyroid gland that is responsible for regulating the basal metabolic rate.

Iodine in food varies because it reflects the soil in which the plants are grown or on which animals graze.
Iodine Deficiency

- **Goiter** – cells of the thyroid gland enlarge until it makes a visible lump in the neck

- **Cretinism** – severe iodine deficiency during pregnancy causes fetal death or cretinism
  - Irreversible mental and physical retardation
  - The world’s most common and preventable causes of mental retardation
Iodine deficiency, the thyroid gland enlarges, a condition known as simple goiter.
Iron

Most iron in the body is contained in hemoglobin and myoglobin or occurs as part of enzymes in the energy-yielding pathways.
**Iron-deficiency anemia** is a problem worldwide.

Normal red blood cells. Both size and color are normal.

Blood cells in iron-deficiency anemia. These cells are small and pale because they contain less hemoglobin.
### What Happens to a Person Who Lacks Iron?

**Table 8-8: The Mental Symptoms of Anemia**

<table>
<thead>
<tr>
<th>Symptom</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apathy, listlessness</td>
</tr>
<tr>
<td>Behavior disturbances</td>
</tr>
<tr>
<td>Clumsiness</td>
</tr>
<tr>
<td>Hyperactivity</td>
</tr>
<tr>
<td>Irritability</td>
</tr>
<tr>
<td>Lack of appetite</td>
</tr>
<tr>
<td>Learning disorders (vocabulary, perception)</td>
</tr>
<tr>
<td>Low scores on latency and associative reactions</td>
</tr>
<tr>
<td>Lowered IQ</td>
</tr>
<tr>
<td>Reduced physical work capacity</td>
</tr>
<tr>
<td>Repetitive hand and foot movements</td>
</tr>
<tr>
<td>Shortened attention span</td>
</tr>
</tbody>
</table>

Note: These symptoms are not caused by anemia itself but by iron deficiency in the brain. Children with much more severe anemias from other causes, such as sickle-cell anemia and thalassemia, show no reduction in IQ when compared with children without anemia.
What Happens to a Person Who Lacks Iron?

**Pica** – a curious appetite for non-food substances such as ice, clay, paste, soil, or other non-nutritious substances.

- Most often seen in poverty-stricken women and children, mentally ill, and people with kidney failure.
Causes of Iron Deficiency and Anemia

Worldwide, iron deficiency is the most common nutrient deficiency, affecting more than 1.2 billion people.

Usually caused by malnutrition:
- Either from lack of food or from high consumption of the wrong foods.
Can a Person Take in Too Much Iron?

- Iron is toxic in large amounts.
- **Iron overload** in healthy people is prevented by absorbing less iron when iron stores are full.
Hereditary iron overload is a fairly common condition in Caucasian people.

- Intestines absorb iron at a high rate despite the excess iron building up in body tissues.

- Symptoms:
  - Early symptoms: fatigue, mental depression, abdominal pain
  - Late symptoms: liver failure, abnormal heartbeats, diabetes, infections
Iron supplements are a leading cause of fatal accidental poisonings among U.S. children under six years old.
Iron Recommendations and Sources

**DRI RECOMMENDED INTAKES:**
Men: 8 mg/day  
Women (19–50 yr): 18 mg/day  
Women (51+): 8 mg/day

**TOLERABLE UPPER INTAKE LEVEL:**
Adults: 45 mg/day

**CHIEF FUNCTIONS:**
Carries oxygen as part of hemoglobin in blood or myoglobin in muscles; required for cellular energy metabolism.

**DEFICIENCY:**
Anemia: weakness, fatigue, headaches; impaired mental and physical work performance; impaired immunity; pale skin, nailbeds, and mucous membranes; concave nails; chills; pica

**TOXICITY:**
GI distress; with chronic iron overload, infections, fatigue, joint pain, skin pigmentation, organ damage

---

**GOOD SOURCES**

- **CLAMS**\(^1\) (steamed)  
  3 oz = 23.8 mg

- **BEEF STEAK** (lean)  
  3 oz = 2.6 mg

- **NAVY BEANS**\(^2\) (cooked)  
  \(\frac{1}{2} c = 2.3 \text{ mg}\)

- **BLACK BEANS** (cooked)  
  \(\frac{1}{2} c = 1.8 \text{ mg}\)

- **ENRICHED CEREAL** (ready-to-eat)  
  1 c = 8.1 mg

- **SPINACH** (cooked)  
  \(\frac{1}{2} c = 3.2 \text{ mg}\)

- **SWISS CHARD** (cooked)  
  \(\frac{1}{2} c = 3.2 \text{ mg}\)

- **BEEF LIVER** (cooked)  
  3 oz = 5.24 mg

---

\(^1\) These foods provide 10 percent or more of the iron Daily Value in a serving. For a 2,000-calorie diet, the DV is 18 mg/day.
Note: Dried figs contain 0.6 mg per 1/4 cup; raisins contain 0.8 mg per 1/4 cup.

\(^2\) Some clams may contain less, but most types are iron-rich foods.

Legumes contain phytates that reduce iron absorption. Soaking in water before cooking reduces phytates, and consuming legumes with vitamin C or meats increases iron absorption.

Enriched cereals vary widely in iron content.
Iron occurs in two forms in foods:

1. Heme iron is part of hemoglobin and myoglobin in meat, poultry, and fish

2. Nonheme iron found in foods from plants and in the nonheme iron in meats
Question?

Which form of iron do you think is absorbed better?

A. Heme iron
B. Nonheme iron
C. I have no idea

Answer: A: heme iron
Absorbing Iron

This chili dinner provides iron and MFP factor from meat, iron from legumes, and vitamin C from tomatoes. The combination of heme iron, nonheme iron, MFP factor, and vitamin C helps to achieve maximum iron absorption.
Absorbing Iron

- The old-fashioned iron skillet adds supplemental iron to foods.
Zinc works with protein in every organ, helping nearly 100 enzymes and regulating gene expression.
How old does the boy in the picture appear to be? He is 17 years old but is only 4 feet tall. His genitalia are like those of a six year old. The retardation is rightly ascribed to zinc deficiency because it is partially reversible when zinc is restored to the diet. The photo was taken in Egypt.
Zinc is toxic in high doses, and zinc supplements can cause serious illness or even death in high enough doses.
Food Sources of Zinc

DRI RECOMMENDED INTAKES:
Men: 11 mg/day
Women: 8 mg/day

TOLERABLE UPPER INTAKE LEVEL:
Adults: 40 mg/day

CHIEF FUNCTIONS:
Activates many enzymes; associated with hormones; synthesis of genetic material and proteins, transport of vitamin A, taste perception, wound healing, reproduction

DEFICIENCY:
Growth retardation, delayed sexual maturation, impaired immune function, hair loss, eye and skin lesions, loss of appetite

TOXICITY:
Loss of appetite, impaired immunity, reduced copper and iron absorption, low HDL cholesterol (a risk factor for heart disease)

GOOD SOURCES*

OYSTERS* (steamed)
3 oz = 72 mg

BEEF STEAK (lean)
3 oz = 4.9 mg

YOGURT (plain)
1 c = 2.2 mg

SHRIMP (cooked)
3 oz = 1.5 mg

ENRICHED CEREAL
(ready-to-eat)
1 c = 3.8 mg

PORK CHOP
3 oz = 2 mg

*These foods provide 10 percent or more of the zinc Daily Value in a serving. For a 2,000-calorie diet, the DV is 15 mg/day.

*A rare inherited form of zinc malabsorption causes additional and more severe symptoms.

*Some oysters contain more or less than this amount, but all types are zinc-rich foods.

*Enriched cereals vary widely in zinc content.
Selenium works with an enzyme to protect body compounds from oxidation.

A deficiency induces a disease of the heart.

Deficiencies are rare in developed countries, but toxicities can occur from overuse from supplements.
Fluoride stabilizes bones and makes teeth resistant to decay.

Excess fluoride discolors teeth; large doses are toxic.
Fluoride

Key:
- <49%
- 50%–74%
- >75%
To prevent fluorosis, young children should not swallow toothpaste.
Chromium works with the hormone insulin to control blood glucose concentrations.

Chromium is present in a variety of unrefined foods.

It is estimated that 90 percent of U.S. adults consume less than the recommended minimum intake of 50 micrograms a day.
Copper is needed to form hemoglobin and collagen and assists in many other body functions.

Deficiency is rare.

Good food sources include: organ meats, seafood, nuts, and seeds.
Other Trace Minerals and Some Candidates

- Many different trace elements play important roles in the body.
- All are toxic in excess.
- Examples: molybdenum, manganese, boron, cobalt, nickel, silicon
Low calcium intakes are associated with:

- Adult bone loss
- High blood pressure
- Colon cancer
- Kidney stones
- Lead poisoning
Food Feature: Meeting the Need for Calcium

Key:
- Milk
- Cheese
- Yeast bread
- Ice cream, sherbet, frozen yogurt
- Cakes, cookies, quick breads, doughnuts
- Other sources\(^a\)
<table>
<thead>
<tr>
<th>Category</th>
<th>Suggested Minimum Daily Fluid Milk Intakes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Young Children</td>
<td>2 cups</td>
</tr>
<tr>
<td>Teenagers</td>
<td>3 cups</td>
</tr>
<tr>
<td>Adults</td>
<td>3 cups</td>
</tr>
<tr>
<td>Pregnant or lactating women</td>
<td>3 cups</td>
</tr>
<tr>
<td>Women past menopause</td>
<td>3 cups</td>
</tr>
</tbody>
</table>
Chocolate milk is an excellent source of calcium for those who can afford the calories.
**Food Feature: Meeting the Need for Calcium**

- **50% absorbed**: cauliflower, watercress, Chinese cabbage, head cabbage, brussels sprouts, rutabaga, kohlrabi, kale, mustard greens, bok choy, broccoli, turnip greens
- **30% absorbed**: milk, yogurt, cheese, calcium-fortified soy milk, calcium-set tofu, calcium-fortified juices and drinks
- **20% absorbed**: almonds, sesame seeds, beans (pinto, red, and white)
- **5% absorbed**: spinach, rhubarb, Swiss chard
**Food Feature: Meeting the Need for Calcium**

- **Recommendation:** 3 cups (or the equivalent)\(^b\)

![Graph showing average daily intake of calcium over time](graph-image)
An estimated 44 million people in the U.S. – the majority of them women over 50 – have or are developing osteoporosis.

Each year, ~ 1,500,000 people break a hip, leg, arm, hand, ankle, or other bone due to osteoporosis.

About 1/5 of people with hip fractures die within a year.
# Development of Osteoporosis

## Table C8-1: Osteoporosis Terms

- **cortical bone** the ivorylike outer bone layer that forms a shell surrounding trabecular bone and that comprises the shaft of a long bone.
- **trabecular** (tra-BECK-you-lar) **bone** the weblike structure composed of calcium containing crystals inside a bone’s solid outer shell. It provides strength and acts as a calcium storage bank.
Development of Osteoporosis

Electron micrograph of healthy trabecular bone

Electron micrograph of trabecular bone affected by osteoporosis
Development of Osteoporosis

- **Trabecular bone** – is more metabolically active than cortical bone and is tapped to raise blood calcium when the day’s supply runs short.
  - Loss of trabecular bone begins to be significant for men and women around age 30.

- **Cortical bone** – calcium can also be withdrawn but more slowly.
  - Loss of cortical bone begins at about age 40.
Development of Osteoporosis

50 years old 80 years old

6 inches lost
Toward Prevention – Understanding the Causes of Osteoporosis

Causes:

- Gender
- Advanced age
- Genetics
- Environment
  - Poor calcium and vitamin D nutrition
  - Estrogen deficiency in women
  - Lack of physical activity
  - Being underweight
  - Use of tobacco and abuse of alcohol
  - Possibly, excess protein, sodium, caffeine, and soft drinks; and inadequate protein, vitamin K, and other nutrients
A strong genetic component contributes to osteoporosis, reduced bone mass, and the increased risk of fragility of bones.

Over 170 genes are under investigation and each may interact with others and with environmental factors, such as vitamin D and calcium nutrition.
Risks of osteoporosis differ by race and ethnicity:

- African American women may lose bone at just half the rate of white women.
- The bone density of Mexican Americans falls somewhere in between.
- Asians from China and Japan, Hispanics from Central and South America, and Inuits from St. Lawrence Island all have lower bone densities than do northern Europeans.
Vitamin D and calcium affect bone deposition and withdrawal.

Most girls in their bone-building years fail to meet their calcium needs.
Calcium and Vitamin D

- Higher peak bone mass
- Lower peak bone mass
- Bone mass danger zone
- Osteoporosis

Time:
- Age 30
- Menopause
- Age 60
- Age 70
# Understanding the Causes of Osteoporosis

<table>
<thead>
<tr>
<th>RISK FACTORS</th>
<th>PROTECTIVE FACTORS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High Correlation</strong></td>
<td></td>
</tr>
<tr>
<td>Advanced age</td>
<td>Black race</td>
</tr>
<tr>
<td>Alcoholism, heavy drinking</td>
<td>Estrogens, long-term use</td>
</tr>
<tr>
<td>Chronic steroid use</td>
<td></td>
</tr>
<tr>
<td>Female gender</td>
<td></td>
</tr>
<tr>
<td>Rheumatoid arthritis</td>
<td></td>
</tr>
<tr>
<td>Surgical removal of ovaries or testes</td>
<td></td>
</tr>
<tr>
<td>Thinness or weight loss</td>
<td></td>
</tr>
<tr>
<td>White race</td>
<td></td>
</tr>
<tr>
<td><strong>Moderate Correlation</strong></td>
<td></td>
</tr>
<tr>
<td>Chronic thyroid hormone use</td>
<td>Having given birth</td>
</tr>
<tr>
<td>Cigarette smoking</td>
<td>High body weight</td>
</tr>
<tr>
<td>Diabetes (insulin-dependent, type 1)</td>
<td>High-calcium diet</td>
</tr>
<tr>
<td>Early menopause</td>
<td>Regular physical activity</td>
</tr>
<tr>
<td>Excessive antacid use</td>
<td></td>
</tr>
<tr>
<td>Family history of osteoporosis</td>
<td></td>
</tr>
<tr>
<td>Low-calcium diet</td>
<td></td>
</tr>
<tr>
<td>Sedentary lifestyle</td>
<td></td>
</tr>
<tr>
<td>Vitamin D deficiency</td>
<td></td>
</tr>
<tr>
<td><strong>May Be Important but Not Yet Proved</strong></td>
<td></td>
</tr>
<tr>
<td>Caffeine intake</td>
<td>Adequate vitamin K intake</td>
</tr>
<tr>
<td>High-fiber diet</td>
<td>Low-sodium diet (later years)</td>
</tr>
<tr>
<td>High blood homocysteine</td>
<td></td>
</tr>
<tr>
<td>High-protein diet</td>
<td></td>
</tr>
<tr>
<td>Lactose intolerance</td>
<td></td>
</tr>
</tbody>
</table>
Understanding the Causes of Osteoporosis

These Young People are Putting Bone in the Bank
Diagnosis and Medical Treatment

- Diagnosis includes measuring bone density using an advanced form of X-ray (DEXA) or ultrasound.

- Estrogen therapy can help nonmenstruating women prevent further bone loss and reduce the incidence of fractures.

- Several drugs also reverse bone loss.
  - Some inhibit the activities of the bone-dismantling cells
  - Others stimulate the bone-building cells
# Calcium Recommendations

## TABLE C8-3  A Lifetime Plan for Healthy Bones

### ChildHood

<table>
<thead>
<tr>
<th>Ages</th>
<th>Goal</th>
<th>Guidelines</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 through 12 or 13 years</td>
<td>Grow strong bones.</td>
<td>▪ Use milk as the primary beverage to meet the need for calcium within a balanced diet that provides all nutrients.</td>
</tr>
<tr>
<td>(sexual maturity)</td>
<td></td>
<td>▪ Play actively in sports or other activities.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ Limit television and other sedentary entertainment.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ Do not start smoking or drinking alcohol.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ Drink fluoridated water.</td>
</tr>
</tbody>
</table>

### Adolescence Through Young Adulthood

<table>
<thead>
<tr>
<th>Ages</th>
<th>Goal</th>
<th>Guidelines</th>
</tr>
</thead>
<tbody>
<tr>
<td>13 or 14 through 30 years</td>
<td>Achieve peak bone mass.</td>
<td>▪ Choose milk as the primary beverage, or if milk causes distress, include other calcium sources.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ Commit to a lifelong program of physical activity.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ Do not smoke or drink alcohol—if you have started, quit.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ Drink fluoridated water.</td>
</tr>
<tr>
<td>AGES</td>
<td>GOAL</td>
<td>GUIDELINES</td>
</tr>
<tr>
<td>-------------------------</td>
<td>-----------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>31 through 50 years</td>
<td>Maximize bone retention.</td>
<td>- Continue as for 13- to 30-year-olds.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Adopt bone-strengthening exercises.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Obtain the recommended amount of calcium from food.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Take calcium supplements only if calcium needs cannot be met through foods.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>AGES</th>
<th>GOAL</th>
<th>GUIDELINES</th>
</tr>
</thead>
<tbody>
<tr>
<td>51 years and above</td>
<td>Minimize bone loss.</td>
<td>- Continue as for 13- to 30-year-olds.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Continue striving to meet the calcium need from diet.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Continue bone-strengthening exercises.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Obtain a bone density test; follow physician’s advice concerning bone-restoring medications and supplements.</td>
</tr>
</tbody>
</table>

Note: The exact ages of cessation of bone accretion and onset of loss vary among people, but in general, data indicate that the skeleton continues to accrete mass for approximately 10 years after adult height is achieved and begins to lose bone around age 35.
Calcium Recommendations

### Table C8-4 Calcium Supplement Risks

People who take calcium supplements risk:

- **Impaired iron status.** Calcium inhibits iron absorption.
- **Accelerated calcium loss.** Calcium-containing antacids that also contain aluminum and magnesium hydroxide cause a net calcium loss.
- **Urinary tract stones or kidney damage in susceptible individuals.** People who have a history of kidney stones should be monitored by a physician and choose calcium citrate if they must take supplements.
- **Exposure to contaminants.** Some preparations of bone meal and dolomites are contaminated with hazardous amounts of arsenic, cadmium, mercury, and lead.
- **Vitamin D toxicity.** Vitamin D, which is present in many calcium supplements, can be toxic. Users must eliminate other concentrated vitamin D sources.
- **Excess blood calcium.** This complication is seen only with doses of calcium fourfold or more greater than customarily prescribed.
- **Milk alkali syndrome.** This condition is rare, but not absent. It is characterized by high blood calcium, metabolic alkalosis, and renal failure. Early symptoms include irritability, headaches, and apathy.
- **Other nutrient interactions.** Calcium inhibits absorption of magnesium, phosphorus, and zinc.
- **Drug interactions.** Calcium and tetracycline form an insoluble complex that impairs both mineral and drug absorption.
- **GI distress.** Constipation, intestinal bloating, and excess gas are common.
Calcium Supplements

<table>
<thead>
<tr>
<th>Table C8-5</th>
<th>Calcium Supplement Terms</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>amino acid chelates</strong> (KEY-lates) compounds of minerals (such as calcium) combined with amino acids in a form that favors their absorption. A chelating agent is a molecule that surrounds another molecule and can then either promote or prevent its movement from place to place (<em>chele</em> means “claw”).</td>
<td></td>
</tr>
<tr>
<td><strong>antacids</strong> acid-buffering agents used to counter excess acidity in the stomach. Calcium-containing preparations (such as Tums) contain available calcium. Antacids with aluminum or magnesium hydroxides (such as Rolaid) can accelerate calcium losses.</td>
<td></td>
</tr>
<tr>
<td><strong>bone meal</strong> or <strong>powdered bone</strong> crushed or ground bone preparations intended to supply calcium to the diet. Calcium from bone is not well absorbed and is often contaminated with toxic materials such as arsenic, mercury, lead, and cadmium.</td>
<td></td>
</tr>
<tr>
<td><strong>calcium compounds</strong> the simplest forms of purified calcium. They include calcium carbonate, citrate, gluconate, hydroxide, lactate, malate, and phosphate. These supplements vary in the amount of calcium they contain, so read the labels carefully. A 500-milligram tablet of calcium gluconate may provide only 45 milligrams of calcium, for example.</td>
<td></td>
</tr>
<tr>
<td><strong>dolomite</strong> a compound of minerals (calcium magnesium carbonate) found in limestone and marble. Dolomite is powdered and is sold as a calcium-magnesium supplement but may be contaminated with toxic minerals, is not well absorbed, and interacts adversely with absorption of other essential minerals.</td>
<td></td>
</tr>
<tr>
<td><strong>oyster shell</strong> a product made from the powdered shells of oysters that is sold as a calcium supplement, but is not well absorbed by the digestive system.</td>
<td></td>
</tr>
<tr>
<td>CALCIUM SOURCE</td>
<td>TYPICAL AMOUNT PER SERVING</td>
</tr>
<tr>
<td>---------------------------------------------------</td>
<td>----------------------------</td>
</tr>
<tr>
<td>Antacid medication, regular strength (&quot;Tums&quot; type)</td>
<td>500 mg per 2 tablets</td>
</tr>
<tr>
<td>Breads with “more” calcium*</td>
<td>80 mg per slice</td>
</tr>
<tr>
<td>Calcium-fortified candies or chewable candy supplements</td>
<td>500 mg per dose</td>
</tr>
<tr>
<td>Calcium-fortified or “100% nutrient” cereals</td>
<td>1,000 mg per serving</td>
</tr>
<tr>
<td>Calcium-fortified fat-free milk and milk products</td>
<td>500 mg per 8 oz serving</td>
</tr>
<tr>
<td>Calcium-fortified orange juice or other fruit beverages</td>
<td>350 mg per 8-oz serving</td>
</tr>
<tr>
<td>Calcium pills</td>
<td>A wide variety of pills provide varying doses. Read the label.</td>
</tr>
<tr>
<td>Meal replacer: cereal bars “with milk”</td>
<td>250 mg</td>
</tr>
<tr>
<td>Meal replacer: “complete nutrition” drinks</td>
<td>200–350 mg per 8-oz drink</td>
</tr>
<tr>
<td>Meal replacer: “energy” bars</td>
<td>300 per one bar</td>
</tr>
</tbody>
</table>

*Bread, though not rich in calcium, is heavily consumed and may contribute significantly to many people’s intakes.