The Skeleton’s Major Functions

1. Enables us to move
2. Supports and protects the body
3. Contains bone marrow
4. Stores large amounts of calcium and phosphorus

Strong Bones Need

- **Essential Nutrients**: Build and maintain bone tissue
- **Balanced Lifestyle**: Keeps bones strong throughout all life stages

Bone Biology

**BONE IS MADE OF**

- **Type 1 Collagen**: that constitutes the interior scaffolding of bone
- **Calcium and Phosphorus Crystals**: that add strength to bone
- **Bone Cells**: that are responsible for bone (re)modeling

**BONE MASS OVER A LIFETIME**

Bones grow throughout childhood, adolescence, and well into adulthood. Around age 34, there is an inevitable loss of bone mass with age, accelerated with menopause in women.

**Modeling**
During childhood and adolescence, bones grow in size and shape.

**Remodeling**
During adulthood, new bone replaces brittle bone, cracks, and deformities.

**GENERAL PATTERN OF BONE DEVELOPMENT OVER TIME**

- Growth
- Modeling
- Remodeling

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**GENERAL PATTERN OF BONE DEVELOPMENT OVER TIME**

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Essential Nutrients

There are 12 nutrients that support bone health:

- Calcium*
- Vitamin D*
- Fluoride
- Magnesium
- Potassium
- Protein
- Vitamin A
- Vitamin C
- Vitamin B₁₂
- Folate
- Vitamin B₆
- Vitamin K

* Calcium and Vitamin D are of primary importance for bone health

Recommendation for dietary intake of essential nutrients:

**Recommended Dietary Allowance (RDA)**
1. Covers the needs of ~98% of the population in a given gender and life-stage group
2. Can be used as a goal for intakes by individuals

**Adequate Intake (AI)**
1. Used when an RDA cannot be determined
## Essential Nutrients Continued

### Calcium

#### Good Sources to help meet the RDA for Calcium

<table>
<thead>
<tr>
<th>Source</th>
<th>mg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Women &gt;50 years</td>
<td>1,200</td>
</tr>
<tr>
<td>Men &gt;70 years</td>
<td>1,200</td>
</tr>
<tr>
<td>Women ≤50 years</td>
<td>1,000</td>
</tr>
<tr>
<td>Men ≤70 years</td>
<td>1,000</td>
</tr>
<tr>
<td>Plain Yogurt (1 cup)</td>
<td>415</td>
</tr>
<tr>
<td>Sardines (1 can)</td>
<td>351</td>
</tr>
<tr>
<td>Collard Greens (1/4 cup)</td>
<td>300</td>
</tr>
</tbody>
</table>

#### Functions

1. Calcium is a major structural component of bones.
2. Calcium in bone can be released in the blood when the need arises.

Children with low calcium intakes will not reach their maximum bone density and strength.

Low calcium intakes in adults can accelerate bone loss and increase the risk of osteoporosis and fracture.

Supplemental calcium (and vitamin D) primarily benefit elderly adults in nursing care. Whether calcium intakes beyond the RDA can reduce risk in community-dwelling older adults is debated.

### Vitamin D

#### Good Sources to help meet the RDA* for Vitamin D

<table>
<thead>
<tr>
<th>Source</th>
<th>µg</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Adults &gt;70 years</td>
<td>20</td>
</tr>
<tr>
<td>All Adults 18–70 years</td>
<td>15</td>
</tr>
<tr>
<td>Salmon (3 ounces)</td>
<td>11.6</td>
</tr>
<tr>
<td>Supplements</td>
<td>10</td>
</tr>
<tr>
<td>Milk, Fortified (1 cup)</td>
<td>2.5</td>
</tr>
</tbody>
</table>

#### Functions

1. Vitamin D is a fat-soluble vitamin that promotes bone health through regulating calcium and phosphorus balance in the body.
2. Severe deficiency in children and adults results in serious skeletal disorders.

Older people are at high risk of poor vitamin D status due to little sun exposure, a lower capacity for vitamin D synthesis in skin, and reduced dairy intake. Supplementation has been recommended to support bone health and help prevent falls in this population.

* The LPI recommends 50 µg (2,000 IU)/day of vitamin D for adults. In a 25-hydroxyvitamin D serum test, you should aim for at least 30 ng/mL (75 nmol/L).

### Fluoride

#### Good Sources to help meet the AI for Fluoride

<table>
<thead>
<tr>
<th>Source</th>
<th>µg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluoridated Water (1 cup)</td>
<td>4</td>
</tr>
<tr>
<td>Black Tea (1 cup)</td>
<td>1</td>
</tr>
</tbody>
</table>

#### Function

1. Fluoride increases the structural stability of bones through interacting with calcium phosphate salts.

Fluoride exposure through community water fluoridation (<3.4mg/day) has no benefit in the prevention of osteoporosis and fracture.

Fluoride supplementation is not approved for use in the prevention or treatment of osteoporosis.
Essential Nutrients Continued

**MAGNESIUM**

**Good Sources to help meet the RDA for Magnesium**

<table>
<thead>
<tr>
<th>Source</th>
<th>Magnesium (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men &gt;30 years, 420 mg/day</td>
<td></td>
</tr>
<tr>
<td>Men 19–30 years, 400 mg/day</td>
<td></td>
</tr>
<tr>
<td>Women &gt;30 years, 320 mg/day</td>
<td></td>
</tr>
<tr>
<td>Women 19–30 years, 310 mg/day</td>
<td></td>
</tr>
<tr>
<td>Spinach (1 cup)</td>
<td>157 mg</td>
</tr>
<tr>
<td>Brown Rice (1 cup)</td>
<td>86 mg</td>
</tr>
<tr>
<td>Almonds (1 ounce, 23 nuts)</td>
<td>77 mg</td>
</tr>
</tbody>
</table>

**Function**

1. About 60% of magnesium is found in bone, which can supply the body when need arises.

Higher magnesium intakes are linked to lower risk of poor vitamin D status.

There is no evidence that magnesium supplementation could help prevent osteoporosis and fracture.

**POTASSIUM**

**Good Sources to help meet the AI for Potassium**

<table>
<thead>
<tr>
<th>Source</th>
<th>Potassium (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Adults, 4,700 mg/day</td>
<td></td>
</tr>
<tr>
<td>Potato with Skin (1 medium)</td>
<td>926 mg</td>
</tr>
<tr>
<td>Prunes (¼ cup)</td>
<td>637 mg</td>
</tr>
<tr>
<td>Banana (1 medium)</td>
<td>422 mg</td>
</tr>
<tr>
<td>Prunes (½ cup)</td>
<td>637 mg</td>
</tr>
<tr>
<td>Potato with Skin (1 medium)</td>
<td>926 mg</td>
</tr>
<tr>
<td>Brown Rice (1 cup)</td>
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</tr>
</tbody>
</table>

**Function**

1. Potassium salts may prevent calcium release from bone and loss of calcium in the urine that are caused by the consumption of diets with high sources of acid (fish, meat, cheese) and low in sources of alkali (fruit and vegetables).

Adopting a diet that increases potassium intake and reduces sodium intake (i.e., high in fruit, vegetables, and dairy; low in meat) might help support bone health.

**PROTEIN**

**Good Sources to help meet the RDA for Protein**

<table>
<thead>
<tr>
<th>Source</th>
<th>Protein (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men, 56 g/day</td>
<td></td>
</tr>
<tr>
<td>Women, 46 g/day</td>
<td></td>
</tr>
<tr>
<td>Turkey (3 oz)</td>
<td>25 g</td>
</tr>
<tr>
<td>Peanuts (¼ cup)</td>
<td>17 g</td>
</tr>
<tr>
<td>Pinto Beans (½ cup)</td>
<td>11 g</td>
</tr>
<tr>
<td>All Adults, 4,700 mg/day</td>
<td></td>
</tr>
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<td>17 g</td>
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<tr>
<td>Pinto Beans (½ cup)</td>
<td>11 g</td>
</tr>
</tbody>
</table>

**Function**

1. Proteins are essential to build strong bones.

Adequate protein intakes are needed to maintain muscle mass and limit falls and fractures in older adults.

Higher protein intakes are likely to be protective unless calcium intakes are inadequate, in which case higher protein intakes may be harmful.
**Essential Nutrients Continued**

### VITAMIN A

**Good Sources to help meet the RDA for Vitamin A**

- **Men,** 900 µg RAE/day
- **Women,** 700 µg RAE/day
- Sweet Potato, Canned (¼ cup) 555 µg RAE
- Carrot (¼ cup) 534 µg RAE
- Egg (1 large) 80 µg RAE

### VITAMIN C

**Good Sources to help meet the RDA for Vitamin C**

- **All Adults,** 400 mg/day
- Sweet Red Pepper (¼ cup) 95 mg
- Kiwifruit (1 medium) 90 mg
- Strawberries (1 cup) 85 mg

### VITAMIN K

**Good Sources to help meet the AI for Vitamin K**

- **Kale (1 cup)** 472 µg
- **Spinach (1 cup)** 145 µg
- **Canola Oil (1 tbsp)** 25 µg

---

**Function**

1. **Vitamin A (retinol)** is a fat-soluble vitamin involved in the growth and differentiation of virtually all cells in the body.

Striving for the RDA for Vitamin A is a safe goal for optimizing bone health: habitual Vitamin A intakes greater than the RDA may increase the risk of osteoporosis and fracture.

Vitamin A supplements should be reserved for undernourished populations and those with evidence of vitamin A deficiency.

1. **Vitamin C** is required during the synthesis of collagen, which constitutes 90% of the bone matrix upon which bone minerals are deposited.

The evidence is too limited to suggest a benefit of vitamin C supplements in the prevention of bone loss.

1. **Vitamin K** is essential for the activity of several bone proteins involved in bone formation and turnover.

There is little evidence supporting a benefit of vitamin K supplementation in the prevention of osteoporosis.

Taking vitamin K supplements can be dangerous for people at risk of blood clots and those taking blood-thinning medications.
### Essential Nutrients Continued

#### VITAMIN B₆

**Good Sources to help meet the RDA for Vitamin B₆**

- **Men (<50),** 1.7 mg/day
- **Women (<50),** 1.5 mg/day
- **Adults (19–50),** 1.3 mg/day

**Turkey (3 ounces)**

- 0.7 mg

**Salmon (3 ounces)**

- 0.65 mg

**Pistachio Nuts (1 ounce)**

- 0.5 mg

### FOLATE

**Good Sources to help meet the RDA for Folate**

- Adult, 400 µg DFE/day
- Adults (19–50), 240 µg DFE/day

**Turkey (3 oz)**

- 84 µg

**Salmon (3 oz)**

- 78 µg

**Pistachio Nuts (1 oz)**

- 50 µg

**Spinach (½ cup)**

- 39 µg

**Lentils (½ cup)**

- 131 µg DFE

**Enriched Sliced Bread (1 slice)**

- 84 µg DFE

**Adults, 600 µg DFE/day**

**Pregnant Women, 600 µg DFE/day**

### VITAMIN B₁₂

**Good Sources to help meet the RDA* for Vitamin B₁₂**

- **Adults over 50,** 100–400 µg per day

**Clams (3 oz)**

- 84 µg

**Egg (1 large)**

- 0.4 µg

**Turkey (3 oz)**

- 0.8 µg

**Adults (19–50),** 2.4 µg/day

**Men (>50),** 1.7 mg/day

**Women (>50),** 1.5 mg/day

**Adults (19–50),** 1.3 mg/day

**Pregnant Women, 600 µg DFE/day**

**Adults, 400 µg DFE/day**

**mg = milligram; µg = microgram; DFE = Dietary Folate Equivalents**

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### Functions of B vitamins

1. Vitamin B₆, folate and vitamin B₁₂ work together to lower blood homocysteine concentration.

2. Too much homocysteine in the blood is associated with reduced bone mineral density and osteopenia.

Meeting recommended intake levels for B vitamins with food and/or supplements helps to lower homocysteine concentration in blood.

However, B-vitamin supplementation does not reduce the risk of fracture.

*For adults over 50, the LPI recommends 100–400 µg per day of supplemental vitamin B₁₂.*