Functions of the skeleton

- Protect internal organs
- Transmit noise
- Mineral storage
- Support to generate negative pressure for breathing
- Locomotion
- Niche for marrow stem cells
- Buffer in acidosis

- Glucose metabolism (secretes osteocalcin)
- Phosphate metabolism (secretes FGF23)
Causes of osteoporosis

- genetic diseases
- neurologic disease
- parathyroid disease
- cystic fibrosis
- diabetes
- hepatic disease
- hypogonadism
- muscle disease
- lupus, rheumatoid arthritis
- metabolic acidosis
- chronic inflammation
- weight loss
- depression
- hyperthyroidism
- COPD, smoking
- malabsorption, malnutrition
- Cushings syndrome
- renal disease
- marrow disease
- medications (prednisone)
- toxins, alcohol, radiation
- hemochromatosis
- low vitamin D
- bedrest
Risks in cancer survivors

Osteoporosis is very common, with many risk factors. Cancer survivors may have particular increases in risk.

Medications can be harmful to bone cells
Sex hormones may be lowered
Weight loss may occur
Patients are too tired to get exercise
Radiation can damage bone cells/stem cells
Other diseases may be more common
Skeletal effects of chemotherapy

- Causes hypogonadism
- Decreases bone density
- Decreases colony-forming-units from bone
- Impaires osteoblast function
Bone Loss with cancer treatments

Brown and Guise

Cancer treatment-associated bone loss

- Normal men: 0.5%
- Late menopausal women: 1.0%
- Early menopausal women: 2.0%
- Aromatase inhibitor (AI) therapy: 2.6%
- Bone marrow transplant: 3.3%
- Androgen deprivation therapy: 4.6%
- AI therapy plus gonadotropin-releasing hormone agonist: 7.0%
- Ovarian failure secondary to chemotherapy: 7.7%

Lumbar spine BMD loss at 1 year (%)
Fractures in Breast Cancer Survivors in WHI

Chen, Archives Int Med 2005
Gender: Men & Osteoporosis

Under-diagnosed

Unrecognized

Under-reported

Inadequately researched
Fracture risk in men with history of prostate cancer (case-control study from Denmark)

Men who had prostate cancer had twice as many fractures as men without cancer.

Osteoporosis Myths

“It’s too late for me to do anything about osteoporosis.”
<table>
<thead>
<tr>
<th>Food</th>
<th>Calcium Content (in mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total cereal, 1 bowl</td>
<td>1000</td>
</tr>
<tr>
<td>Viactive, 1 chew</td>
<td>500</td>
</tr>
<tr>
<td>Yogurt, 1 cup</td>
<td>350</td>
</tr>
<tr>
<td>Citracal, 1 caplet</td>
<td>315</td>
</tr>
<tr>
<td>Orange juice, fortified, 1 cup</td>
<td>300</td>
</tr>
<tr>
<td>TUMS EX, 1 pill</td>
<td>300</td>
</tr>
<tr>
<td>Milk, 1 cup</td>
<td>300</td>
</tr>
<tr>
<td>Macaroni &amp; cheese, 1 cup</td>
<td>250</td>
</tr>
<tr>
<td>Lasagna, 1 cup</td>
<td>250</td>
</tr>
<tr>
<td>Soy milk, fortified</td>
<td>225</td>
</tr>
<tr>
<td>1 cup (bioavailable)</td>
<td></td>
</tr>
<tr>
<td>Cheddar cheese, 1 oz</td>
<td>200</td>
</tr>
<tr>
<td>Collards, 1/2 cup</td>
<td>200</td>
</tr>
<tr>
<td>String cheese, 1 oz</td>
<td>200</td>
</tr>
<tr>
<td>Tofu, nigari, 6 &quot;</td>
<td>120</td>
</tr>
<tr>
<td>Pizza, 1 slice</td>
<td>120</td>
</tr>
<tr>
<td>Goldfish crackers, 60</td>
<td>100</td>
</tr>
<tr>
<td>LIFE cereal, 1 bowl</td>
<td>100</td>
</tr>
<tr>
<td>Bok Choy, 1/2 cup</td>
<td>100</td>
</tr>
<tr>
<td>Taco with cheese</td>
<td>100</td>
</tr>
<tr>
<td>Almonds, dry roasted, 1/4 cup</td>
<td>100</td>
</tr>
<tr>
<td>Kale, 1 cup</td>
<td>90</td>
</tr>
<tr>
<td>Oysters, canned, 1 cup</td>
<td>75</td>
</tr>
<tr>
<td>Ice cream, 1/2 cup</td>
<td>60</td>
</tr>
<tr>
<td>Parmesan cheese, 2 Tbsp</td>
<td>60</td>
</tr>
<tr>
<td>Kippered snacks, 1 can</td>
<td>60</td>
</tr>
<tr>
<td>Kidney beans, 1/2 cup raw (bioavailable)</td>
<td>60</td>
</tr>
<tr>
<td>Black beans, 1/2 cup raw (bioavailable)</td>
<td>60</td>
</tr>
<tr>
<td>Cottage cheese, 1/2 cup</td>
<td>60</td>
</tr>
<tr>
<td>Figs, dried, 2</td>
<td>60</td>
</tr>
<tr>
<td>Tortillas, 2</td>
<td>53</td>
</tr>
<tr>
<td>Broccoli, 1 cup</td>
<td>50</td>
</tr>
<tr>
<td>m&amp;m's, 50</td>
<td>40</td>
</tr>
<tr>
<td>Bread, 1 slice</td>
<td>20</td>
</tr>
<tr>
<td>Potato, medium</td>
<td>20</td>
</tr>
<tr>
<td>Spinach, 1 cup (bioavailable)</td>
<td>zero</td>
</tr>
</tbody>
</table>

**Calcium Recommendation:**

1200mg/day
### Food labels for calcium

A food label showing nutritional information for calcium.

<table>
<thead>
<tr>
<th>Nutrition Facts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serving Size 3/4 cup (170g)</td>
</tr>
<tr>
<td>Servings Per Container 1</td>
</tr>
<tr>
<td><strong>Amount Per Serving</strong></td>
</tr>
<tr>
<td><strong>Calories</strong> 110  Fat Calories 0</td>
</tr>
<tr>
<td>% Daily Value*</td>
</tr>
<tr>
<td>Total Fat 0g 0%</td>
</tr>
<tr>
<td>Saturated Fat 0g 0%</td>
</tr>
<tr>
<td>Trans Fat 0g</td>
</tr>
<tr>
<td>Cholesterol 0mg 0%</td>
</tr>
<tr>
<td>Sodium 90mg 4%</td>
</tr>
<tr>
<td>Potassium 350mg 10%</td>
</tr>
<tr>
<td>Total Carbohydrate 20g 7%</td>
</tr>
<tr>
<td>Dietary Fiber 0g 0%</td>
</tr>
<tr>
<td>Sugars 16g</td>
</tr>
<tr>
<td>Protein 7g 14%</td>
</tr>
<tr>
<td><strong>Vit.A 0%</strong>  <strong>Vit.C 3%</strong>  <strong>Calc. 25%</strong>  <strong>Iron 2%</strong></td>
</tr>
</tbody>
</table>

*Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs.

100% = 1000 mg
so 25% = 250 mg
Calcium

Too much calcium is bad for you:

Kidney stones
Calcium deposits in the kidney
Calcium deposits in the blood vessels
Calcium

I suggest getting at least half of your calcium from food.

For example, two servings of high-calcium foods: yogurt, milk, cheese, orange juice with calcium

Or three servings of medium-calcium foods: kale, beans, fortified cereals, collard greens, almonds, soy (tofu)
Calcium supplements

1200mg/day calcium from food plus supplements

<table>
<thead>
<tr>
<th>Brand</th>
<th>Cost per 1000mg</th>
<th>Calcium per pill</th>
</tr>
</thead>
<tbody>
<tr>
<td>TUMS</td>
<td>13¢</td>
<td>300</td>
</tr>
<tr>
<td>Caltrate</td>
<td>14¢</td>
<td>600</td>
</tr>
<tr>
<td>OSCAL</td>
<td>17¢</td>
<td>500</td>
</tr>
<tr>
<td>Viatris</td>
<td>26¢</td>
<td>500</td>
</tr>
<tr>
<td>Citracal</td>
<td>29¢</td>
<td>315</td>
</tr>
</tbody>
</table>

These reliable brands are equally effective.
Calcium supplements in gut

Some expensive pills do not get absorbed
Chewable forms get absorbed very well
Calcium requirements: exceptions

Patients with bone marrow transplants who have graft vs host disease may need more calcium.

Patients with intestinal disease may also need more calcium.

Some patients with high calcium in the blood will need less calcium.
Vitamin D

• Vitamin D: good for bones
  – Cholecalciferol (D₃) a little better than ergocalciferol (D₂)
  600 IU/day younger than 70
  800 IU/day older than 70

• Vitamin A: too much is bad for bones
  – Don’t give two multivitamin supplements
  – Caution with cod liver oil
Vitamin D “fad”

Some people have suggested that really high doses of vitamin D will help with osteoporosis or with cancer (and a long list of other diseases). None of these claims has been proven.

The people who recommend them don’t realize that there are risks with too much vitamin D, such as kidney stones and kidney failure. Even the bones dissolve more easily when vitamin D is too high.

Optimal blood levels: 20 to 50 ng/ml
Vitamin D levels in surfers

Binkley, JCEM 2007
Vitamin D and Mortality

NHANES N=13,331

Melamed 2008
Weight-Bearing Exercise

Consult your doctor first
Tai-chi helps reduce falls

- Best to do weight-training exercises AND resistance-training exercises
Exercise in breast cancer survivors

N = 106 enrolled  
67 completed

Winters-Stone, Breast Cancer Res, 2011
RCT of exercise in postmenopausal women with past breast cancer

N = 223, all subjects also received risedronate
Duration 24 months

Waltman Osteoporosis Int, 2010
Body Mass Index

n = 60,000 men and women

DeLaet, Osteoporosis Int 2005
Who’s going to break her hip?
Osteoporosis Diet for low BMI
Prevent Falls!

Falling can be deadly.

Please stay on the trail.
1. Have handrails and plenty of light in all stairways.
2. Wear shoes that give good support and have non-slip soles.
3. Don’t use step stools. Keep items you need within easy reach.
4. Maintain a clear path to the bathroom.
5. Remove all small rugs. They can make you trip.
6. Make sure your walkways are wide enough.
7. Remove things that you may trip over from stairs and places where you walk.
8. Move phone and electrical cords away from walkways and open areas.
9. Make sure that all areas are well lit. Use bright light bulbs.
10. Be aware that some medications, including over-the-counter medicines, can make you dizzy or sleepy. Talk with a healthcare professional about what is best for you.
11. Get your vision checked. Annual vision checks can help eliminate bone-breaking falls.
12. Use non-slip mats in the bathtub or shower. Have grab bars put in next to your toilet and in the bathtub or shower.
Alcohol

Adjusted for BMD

n = 16,971 men and women

Kanis, Osteoporosis Int 2005
Smoking

Kanis, Osteoporosis Int 2005
Medical treatment for bone disease in cancer survivors

Estrogens: In perimenopausal or premenopausal hypogonadal women without hx of estrogen-related cancer

Testosterone: In hypogonadal men without hx of hormone-related cancers.

Raloxifene: In postmenopausal women who have not had tamoxifen (not studied in breast cancer survivors)

Bisphosphonates: Long-term effects still not defined with or without cancer history. Proven fracture efficacy in first 5 years.

Teriparatide: Not indicated for most patients with cancer history.

Denosumab: New medication, long-term effects uncertain, marked suppression of bone formation. May be helpful for limited use such as with aromatase inhibitors.

Calcitonin: Safe and gentle but not as effective.
Bone density in ATAC trial

Eastell & Adams, 2002
Bisphosphonates and fracture prevention in breast cancer trials

Valachis, Gynedol Onc, 2010
Zolendronate in premenopausal women undergoing chemotherapy

N = 101; BMD at one year

Hershman, J Clin Oncol, 2008