

Sanford Medical Center

Aunt Cathy's Guide to Nutrition:



Calcium Odds and Ends:

Food sources, supplements,
and some factors that affect how
well it is absorbed and utilized.

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A table of the amount of calcium in various foods is provided on page 7. The focus of the following pages is the use of calcium supplements. If supplemental calcium is needed to get the right amount (a goal may be as high as 1000-1500 mg/day, depending on age and health factors,) the following information will help you pick a product to use.

Most general vitamin/mineral tablets contain very little calcium (usually less than 250 mg,) so if you need to rely on supplements, you will probably need to use an additional calcium supplement. There are many calcium supplements on the market. A physician or Registered Dietitian (RD) can help you pick the right kind and the amount to use. Here is an overview of the issues to consider:

Absorption:

Form:

Not all supplements are equally well absorbed into the body, and if they are poorly absorbed the calcium cannot be used. As a rule, chewable or liquid products are well absorbed, as is the calcium citrate that is added to some brands of orange juice. Absorption from tablets is variable. You can test the absorbability of a product by placing the tablet in some vinegar. If it has not dissolved in a half hour or so, it is unlikely to be well absorbed in the intestines. **However, a more important factor than the form of calcium in calcium absorption is adequacy of vitamin D, which will be described later.**

Timing:

Generally, taking smaller doses of calcium supplements several times a day results in better absorption than taking just one great big dose daily. For example, taking one calcium carbonate antacid tablet per meal (200 mg each X 3 meals) would result in better absorption than taking a tablet that provided all 600 mg at once. However, if unable, unwilling or unlikely to take a supplement more than once a day, the higher calcium product would be a better choice.

For most calcium supplements, absorption is best when taken with a meal, except with very high fiber foods such as bran cereal. Ideally, they should also be taken at a different time from other mineral supplements, because some compete for absorption. For example, if taking iron supplements or a multi-vitamin/mineral supplement at one meal, take the calcium supplement with a different meal for best absorption.

However, although this kind of recommendation is often heard, the absorption differences they are describing are aimed at achieving “**ideal absorption**” of a supplement. **In reality, this issue is much less of a real problem than not taking a supplement if you need one.** For example, if one product claims that it is 5% better absorbed than another, it is only important if those people’s needs are not met and they were truly relying on that 10 mg of calcium to save their lives or bones. One could always just take a little more from food or pill sources to account for the slight difference in absorption.

Remember that the ads you see recommending particular products are designed to convince you that one product is clearly much better than another. It is about market share and not necessarily about science. In one of the ads a lady tells us that “My doctor said only this product can be taken with or without food” with the implication that one can barely squeeze any calcium out of food and supplements with any other brand. As noted above, in general this kind of small mathematical difference in absorption is not very important unless you are living on the edge with no options.

Here’s a question: Who the heck is HER doctor and why should we do what she says that he said? The implication is that this one anonymous doctor has the inside track on these issues. Do physician specialist organizations recommend that particular calcium product (calcium citrate) over others based on research demonstrating great absorption differences between the products? Well, no. And if that kind of claim COULD be made, you can be sure that it would be shouted to the rafters if the manufacturer had that kind of backing for their claims. Instead we are urged to rely on hearsay that some lady’s doctor told her.

By the way ... there is nothing at all wrong with that product. The calcium in calcium citrate is at least as well absorbed than other calcium forms ... and better than some to a small degree. I recommend it for people who experience some constipation problems with calcium carbonate. For those that have this problem, calcium citrate can be a better choice. However, in general calcium citrate is also a bit more expensive.

Similarly, a competing company says that “more doctors have recommended our product than any other!” That is absolutely true, but primarily because until about 10 years ago their calcium carbonate product was the only one on the market. If you were to count up all the doctors, living and dead, who ever made a calcium supplement recommendation over the last century, I am very sure that it would add up to more doctors recommending calcium carbonate (specifically calcium carbonate from oyster shells) than the number of doctors recommending other products which have only been available for a relatively short time. So, it’s a true statement, but not a good reason to pick a particular supplement product.

If worrying about when and how to take a supplement gets in your way of actually taking it, it is clearly best to just take it when it is convenient or likely to be remembered at all.

Personally, I simply do not remember to take things throughout the day. So, I follow Mark Twain's advice and just take everything all at once in the morning and then let 'em fight it out in there! It's WAY better than not taking them at all just because you can't take them perfectly.

The Biggest Factor in Calcium Absorption: Vitamin D Adequacy

As mentioned earlier, by far the **biggest factor in whether calcium in any form is absorbed** is the adequacy of a person's vitamin D status as measured by the amount of 25-hydroxy vitamin D circulating in their blood. If the level of vitamin D in one's blood is at least **30 mg/dL** all these tiny form-of-calcium absorption differences simply go away. Note that 30 mg/dL is the **bottom edge** of normal and not really one's target goal. Levels in the 40s and 50s are clearly safe and achieving levels in that range appear to be some additional benefit in a variety of health conditions.

Also, note that **it is not whether or not the vitamin D is IN the calcium product that matters, but whether the amount in one's blood is adequate.** The vitamin D in the pill does not affect absorption of the calcium it contains ... it is the vitamin D already circulating around in the blood (from what was taken in earlier) that can be activated to enhance calcium absorption in the intestine.

That means that calcium supplements can have vitamin D in them, or one can take a supplement without vitamin D and just be sure to take whatever amount is needed from a separate capsule. Tiny vitamin D capsules containing 2000 to 5000 iu are readily available over the counter and they are safe and inexpensive. Most combination products contain only 400-800 iu of vitamin D, which is insufficient for many people to maintain vitamin D blood levels at or above 30.

How much **may** be needed depends on what one's blood vitamin D level is. Checking the blood level is really the only way to be sure vitamin D is adequate. Inadequacy is very common and very harmful but often unrecognized because it does not make you look funny, so no one sees the problem. However, the **World Health Organization (WHO) estimates that about 50% of the world's population obtains inadequate vitamin D, and this has health consequences far beyond the calcium absorption/ bone issues.**

Safety of Calcium Supplements:

Certain products are still being sold that are not recommended because they have lead or other undesirable and dangerous substances in them. Examples are bone meal and dolomite calcium supplements; these are not recommended, especially for children or during pregnancy. There is also some concern as well about calcium from any "natural" source (such as oyster shell) because pollutants in the environment might be incorporated into the shell. **For this reason, it may be safest to use purified forms of calcium carbonate, calcium citrate, etc.**

While some surveys of selected "natural" calcium supplements have not detected a problem level of lead or other heavy metals in the samples tested, other studies have shown that there is cause for concern. And as described above, some makers of oyster shell calcium supplements suggest that these products are known to be safe because they have been "used in more studies" or "recommended by more physicians."

Again, it sounds impressive until you realize that until quite recently they were the only products on the market! These statements do not address the safety issues, or even absorbability issues. Until the safety issue is fully resolved, it would be safest to use purified forms instead of oyster shell, bone meal or dolomite calcium products.

Cost:

There is a great difference in cost among the various supplements. Some products are quite expensive but not appreciably better than less costly products. Some products require a person to take many tablets a day to obtain the right amount of calcium. If the number of tablets needed to provide the prescribed amount of calcium is great, the likelihood is higher that a person would be unable or unwilling to take the prescribed amount.

It is helpful to evaluate cost per day's supply rather than as cost per tablet. If you have to take four times as many tablets per day to get the prescribed amount of calcium, a product may not be a bargain even if the cost per 100 tablets is less.

Generally, "**calcium gluconate**" and "**calcium lactate**" require a person to take many more tablets to get the same amount of calcium as "calcium carbonate", "calcium phosphate" or "calcium citrate" tablets. They are very good supplements ... they are just pricey and they require taking a lot more pills. Often a generic or store brand will be substantially cheaper than a "brand name" product.

Other Nutrition Interactions with Calcium Supplements:

Magnesium

Magnesium is critical for formation of flexible, less brittle bone, and there are safety concerns (such as a possible increased risk of stroke) when a person takes a large amount of supplemental calcium if magnesium is not adequate. Magnesium in the supplement does not interfere with calcium absorption, so it will often be found in combination supplements.

The RDA levels provide a ratio of about 4-to-1 (4 mg calcium to 1 mg magnesium.) Maintaining that ratio if/when higher calcium amounts are supplemented seems to be a reasonable adjustment. The Center for Disease Control has reported that magnesium is often found to be inadequate in the diets of the majority of Americans.

As magnesium is critical for over 300 functions in the body, there are many good reasons to assure adequacy. Inadequacy is associated with problems like leg cramps, insulin resistance (Type 2 Diabetes), high blood pressure and more brittle bones.

Magnesium inadequacy is often unrecognized because blood tests of magnesium levels reflect kidney function and generally they do not reflect intake adequacy. Additionally, health care professionals rarely try to evaluate the likelihood that a person's magnesium intake might be poor because many of us were not taught that it was a problem nutrient. Well, it IS.

Happily, it is very easy to identify the very best sources of dietary magnesium. It is in very few foods except for **the parts of plants that will turn into a baby plant**: nuts and peanuts, seeds, the germ of grains, nuts, and legumes (dried beans, peas, and lentils.) **This simple rule of thumb makes it easy to ask a few questions and get the picture:**

Question: “Do you eat nuts and peanuts very often? How about whole grains and chili beans or soy beans or baked beans or refried beans?”

Answer 1: “Oh, I LOVE those foods and eat a lot of them!”

Interpretation: magnesium intake is likely just fine.

Answer 2: “Well, nuts and peanuts are high in fat and I am watching my calories. Beans all give me gas so I rarely eat them. I only like white bread and enriched pasta”.

Interpretation: magnesium intake is quite UNlikely to be just fine.

For the person with a “likely-to-be-not-so-hot” magnesium intake from food, it is very reasonable to provide a magnesium supplement either in combination with a calcium supplement or separately. They do not need to be taken together. Most multivitamins have only 10-25% of the RDA for magnesium ... and often none ... so check the label.

(See “Aunt Cathy’s Guide to Nutrition: Magnesium” for more information.)

Vitamin K

Adequacy of vitamin K is needed for activating a hormone (calcitonin, now called osteocalcin) that is important for moving the calcium into the bones. Without it, all the work to obtain and absorb calcium for bone-building is wasted and the calcium you worked so hard to absorb will just be excreted in the urine or deposited in the kidneys and arteries. Not good. There is a diagram of this interaction of calcium, and vitamins D and K in bone-making on the last page.

There is often misunderstanding about taking vitamin K in foods or supplements for people taking a medication to decrease blood clotting to help prevent strokes. The medication is called **Coumadin or warfarin**. When taking this medication, it is very important to take in a consistent amount of vitamin K everyday, but it is very harmful to bone health if a person is deficient in vitamin K. Many people actually obtain far too little vitamin K when using the medication and it can be very harmful. Check with your physician to assure that everything is in balance.

Also note that OTHER medications to prevent blood clots do not operate by interacting with vitamin K, so there is no reason to try to maintain a very consistent vitamin K intake. It is also interesting to note that a food and nutrition supplement plan that assures **a consistent and adequate vitamin K intake** can be matched by your physician.

Vitamin K inadequacy benefits no one, and it is responsible for the relationship found between Coumadin/warfarin use and higher incidence of osteoporosis. It turned out that it wasn't the drug that caused the bone problems – it was the vitamin K deficient diet that caused the problem. Vitamin K is highest in dark green leafy vegetables. So, a diet low in vitamin K would also be low in lutein. Lutein is a pigment (color) that is a potent antioxidant in leafy greens with a role in (among other things) protecting against blindness due to macular degeneration.

Some vitamin K can be produced by bacteria in the intestine. However, recent research has shown that it is not well utilized, and so we are much more dependent on taking in vitamin K from diet or supplements than was previously believed. The standard assumption was that about half of the vitamin K people require was provided by intestinal bacteria, and intake recommendations from foods was set with that idea in mind.. As a result, the current official recommendations appear to be set too low to support optimal health..

As a result, vitamin K intake is often quite low and its inadequacy is rarely recognized. It is rarely tested or even asked about, and the most common way health professionals try to assess vitamin K adequacy by checking the time it takes for blood to clot in people using anticoagulants. However, **impaired ability to clot blood is a very LATE-APPEARING symptom of vitamin K inadequacy. Other important vitamin-k-dependent functions are impaired long before changes in blood-clotting rate are seen.**

Several new discoveries about vitamin K have changed our understanding of it a lot in the past few years.

Here are five:

- 1. For anyone NOT on Couadin/warferin (that is, MOST people) vitamin K is extremely safe.** There is not even an upper intake of safety established for this vitamin because no one has EVER overdosed on it, either from food or supplements. Most of us were taught that it is potentially toxic because it dissolved in fat. Wrong.
- 2. Vitamin K produced by bacteria in our intestines was thought to contribute about half of what we need.** The only people thought to be at risk of vitamin K inadequacy were those taking chronic antibiotics, because those drugs also kill the “friendly” vitamin-K-making bugs. However, it has now been found that the bugs do produce it, but we do not get much of it. **As a result, we are all more reliant on an outside source of vitamin K than we thought.**
- 3. Many vitamin supplements contain no vitamin K at all** because of assumptions that people’s intakes were adequate because of the contribution of the bacteria.
- 4. The recommendations (like the RDA) have recently been found to be insufficient** to assure adequacy in people’s blood because they were set based on the assumption that we also got a lot from intestinal bacteria, which it turns out we don’t.
- 5. People using Coumadin/warfarin are at high risk of vitamin K deficiency** because of misunderstandings on the part of both patients and health professionals about vitamin K safety issues. **Vitamin K inadequacy and inconsistency actually makes the use of this medication MORE dangerous** to use because of increased volatility of blood clotting, and increased calcification of blood vessels.

For more information on the role of vitamin K in calcium metabolism, including prevention of osteoporosis, kidney damage and artery damage leading to cardiovascular disease, please see my other handouts: **“Vitamin K --New Issues in Cardiovascular Health, Renal Health, Osteoporosis, Liver & Colon Cancer, Diabetes, Pregnancy & Varicose Veins”** and one for health care professionals about the issues with one of the common anti-clotting medications: **“Vitamin K -- Focus on the Vitamin K and Warfarin/Coumadin Anticoagulant Drugs Issues”**

Weight-Bearing Activity

Our bones are always breaking themselves down and rebuilding themselves. This is called **remodeling**. The breaking-down activity goes on 24 hours a day. However, **the bone building activity has to be stimulated by weight-bearing activity.**

Weight-bearing activity includes activities like walking, running, dancing, playing ball, doing weight training, and other activities. Inactivity decreases our weight bearing activity, and so it allows the bone breakdown to occur faster than bones can be rebuilt. That is why being “sedentary” --- sitting or lying down much of the time --- can be so bad for bone health.

Being in bed a lot due to illness, or working in a “sit-down” job both can contribute to serious bone loss, but we often have little choice in these matters. However, finding ways to add in weight-bearing activity can really add up for bone health...like taking the stairs, parking farther away from work, and taking walks during breaks. Even if one is in a wheelchair or in bed much of the time, occupational and physical therapists can help design some safe activities, which may involve adaptive weight training or exercise.

Some forms of exercise, like swimming or water aerobics, are less “weight-bearing” because the water does some of the work of holding you up. So they are less helpful in terms of bone building, but they are still excellent forms of exercise for other health benefits. For example, they can be very helpful if a person has joint pain ... having the water support one’s weight can make exercise even possible for some people.

The “builder” cells of bone are called osteoblasts and the “crushers” of bone are called osteoclasts. Some anti-osteoporosis medications work by holding the activity of the crushers down, with the idea that the builders could catch up. To optimize this and enhance the safety of the drugs, it is still extremely important to do weight-bearing exercise (to wake up the builders and get them going) and to assure adequacy of all the nutrients needed to make bones.

Illustrations and a table:

I drew some **cartoons** on this topic for a study guide for a nutrition textbook in 1990. In those days there were no computer-generated art options available. Typing was done on the first Mac computer available to the public. The pictures on the next page I actually had to draw by hand and paste them (with glue!) on the page. The drawings were intended to illustrate some concepts about calcium metabolism, and although they may qualify as ancient art, they are still pertinent.

After that page there is a **table** of the calcium content of food from the Department of Agriculture, to which I added a few comments added. (I can’t help it!) On the last page I made a **diagram** to help sort out some newly recognized interactions of calcium, vitamin D and vitamin K in bone metabolism.

I always learn better with cartoons ... if they don’t help you ... hey! ... Don’t look at them! ☺

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Aunt Cathy's Guide to Nutrition:

After All These Years, It All Keeps Coming
Back to These Two Ideas.

Two Really Good Rules-of-Thumb about Absolutely Everything to Do with Nutrition



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1. “We need everything to do everything.”

Missing any key component interferes with the whole process ... which is why (in this case) just “taking calcium” is unlikely to be as effective as it might be if there is an absence of adequate vitamin K, vitamin D and weight-bearing exercise.

Without all these factors in place, calcium consumed simply does not go where you want it to go. Besides not helping your bones, a lot of other damage can result.

2. “Assure nutrient adequacy instead of just Assuming it.”

I always assume that anyone could easily have some nutrition problem that has been shown to be quite common, generally not visible, potentially very important to health (see #1 above), and I further assume that there is likely something to be done to safely, inexpensively and easily help to correct it.

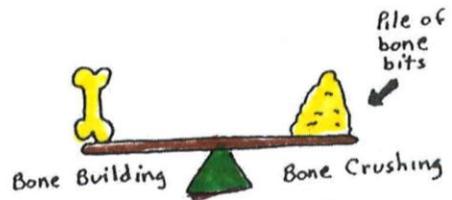
This does not solve all their problems, but it does give them a level playing field to achieve a health goal, and it also makes the ministrations of other health providers just a bit more likely to be effective. It is totally “win-win.”

This does not usually require labs, but it does require knowing and asking the right questions. Finding time to ask anything is difficult, but there are many ways to streamline the process and to do some significant good. As I hope this paper illustrates, failing to assure adequacy will make us much more likely to fail to avoid and/or solve serious and expensive health problems.

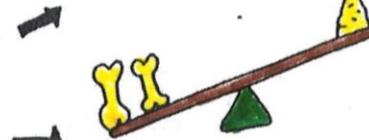
...

The Wonders of Modern Science Department:
Osteoblasts and Osteoclasts

Bone-crusher cells seem to be working all of the time.



When the bone-builder cells are stimulated to work too, bone breakdown and bone buildup are balanced.



With more stimulation of bone-builder cells, there can be a net increase in bone tissue.



When bone-builder cells are not stimulated to work, there is a net loss of bone tissue because the bone-crusher cells continue to chip away at existing bone.

Bob's Bone-Building Business

Osteoblasts build bone

"Osteoblasts and Osteoclasts" Mnemonic

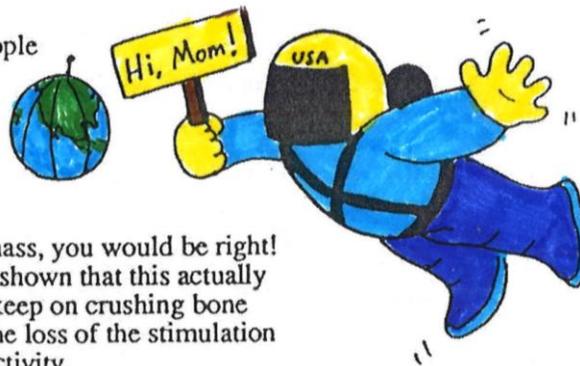
Osteoblasts and osteoclasts are two types of bone cells that are involved in remodeling of bone.

One type is responsible for forming new bone tissue, and the other for breaking down old bone tissue.

Here is a way to remember which is which:

Osteoclasts crush bone.

What would you guess might happen to people in the weightlessness of outer space?



If you guessed that they would lose bone mass, you would be right! Measurements of returning astronauts have shown that this actually happens. It occurs because the osteoclasts keep on crushing bone but the osteoblasts slow down because of the loss of the stimulation that normally comes from weight-bearing activity.

Food Sources of Calcium

Dairy

(Dairy calcium is a well-absorbed form in general, but like all sources of calcium, vitamin D adequacy is necessary for it to be truly well-absorbed. The foods fortified with vitamin D are marked with a star*, and an explanatory note follows at the end.)

	Serving Size	mg
American cheese, processed	1 oz	175
Blue cheese	1 oz	150
Cheddar cheese	1 oz	200
Cottage cheese	1/2 cup	80
Cream cheese	1 oz	25
Ice cream	1 cup	175
Milk* (whole, 2%, fat-free/ skim, and chocolate)	1 cup	300
Calcium/Protein fortified milk*	1 cup	500
Parmesan cheese	1 oz	390
Swiss cheese	1 oz	275
Yogurt (very few products*)	1 cup	275-350

Seafood

Clams, raw	3 oz	60
Oysters, raw	1/2 cup	110
Salmon, canned with bones*	3 oz	165
Sardines, canned with bones*	3 oz	370
Shrimp	3 oz	100

Nuts, Dry Beans and Seeds

Almonds	1/2 cup	150
Beans (cooked)	1/2 cup	45-100
Brazil nuts	1 oz	50
Hazelnuts	1/2 cup	120
Sesame seeds (whole dried)	1 Tblsp	90
Soybeans, roasted "nuts"	1/2 cup	120-230

Fruits and Vegetables Serving Size mg

(calcium absorption is mixed; oxalates decrease the absorption of double-starred ** items.)

Apricots, dried	1/2 cup	45
Asparagus	1/2 cup	15
Beans, green **	1/2 cup	30
Beet greens (cooked)	1/2 cup	75
Broccoli	1/2 cup	70
Cabbage (cooked)	1/2 cup	35
Cabbage, bok choy (cooked)	1/2 cup	125
Carrots	1/2 cup	25
Celery	1/2 cup	25
Collard greens, (cooked) **	1/2 cup	180
Dates	1/2 cup	50
Kale (cooked)	1/2 cup	100

Mustard greens (cooked) **	1/2 cup	95
Onions (cooked)	1/2 cup	25
Parsnips (cooked)	1/2 cup	35
Raisins	1/2 cup	25
Rhubarb (cooked)	1/2 cup	100
Spinach (cooked) **	1/2 cup	85
Squash, summer or winter	1/2 cup	55
Turnip greens (cooked) **	1/2 cup	125
Calcium-fortified orange juice*	1/2 cup	150

* For many years, only milk has been fortified with vitamin D . . . it was not added to cheese, yogurt, ice cream or other dairy foods. In milk the amount supplemented is 100 iu vitamin D per cup. Therefore, the recommended 2-3 dairy servings from suggested eating patterns such as the Food Guide Pyramid would provide no vitamin D unless the only food chosen was milk with vitamin D added, and then it would be too little.

Re: Vitamin D in food.

Recently, SOME other dairy products are being fortified with vitamin D. But this is not yet commonly done for all dairy foods, so remember to look closely at your total vitamin D intake. The amount provided in a typical multivitamin is 400 iu, and the amount in 1 cup of fortified milk or yogurt is usually about 100 iu. Although officially 400 iu is still the RDA amount, there is a huge amount of research and professional opinion from vitamin D researchers that this is simply too low to assure a healthy blood level for a very large number of people. Most recommendations now are for a **daily intake of at least 2000 iu**, with certain groups and individuals needing significantly more (e.g. 2000-5000 iu/day).

This is the result of checking people's vitamin D blood levels instead of simply assuming that they are fine. It suggests that a separate vitamin D capsule is a very good idea. After all, 2000 iu would be achieved by drinking 20 cups of fortified milk daily. That is a very unrealistic approach to assuring vitamin D adequacy. The only naturally good food sources are salmon (3 oz = 340 iu) tuna (3 oz = 150 iu) and shrimp (3 oz = 127 iu.) Next highest is 3 oz of liver with 42 iu and an egg yolk has 27 iu.

For more information, please see "My Current Top Five Easy Ways to Improve Your Family's Nutrition" and "Vitamin D: A Quick Review of Forms, Labs and Other Things People Have Asked Me about Recently."

Lettuce, iceberg 1/4 head 25

(dried kern



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Calcium Odds and Ends:

Absorption and Where it Ends Up

Role of Vitamins D and K

