

# Vitamin D

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### **What is vitamin D?**

Vitamin D is one of the chemicals that the tissues of our body use to unlock the DNA blueprints needed for our cells to produce various of the products required for cell growth, signaling, differentiation, and immunity. Vitamin D is chemically related to cholesterol and to the large family of steroid hormones; it is called, in chemical terms, a “seco-steroid”.

### **What is a vitamin?**

A vitamin is a chemical compound which the body needs to operate the biochemical machinery of our cells, but which the body doesn't make for itself. Vitamins are normally provided by the environment in sufficient quantity so that a living organism can easily get all it needs, thereby avoiding the need to waste energy on making what the environment already provides. Vitamins are typically found in the food we eat or, in the case of vitamin D, manufactured in the skin on exposure to the ultraviolet wave lengths (UV-B) of sunlight. Vitamins are known as “trace nutrients”, because the amount we need every day is often extremely small (frequently in the milligram – thousandth of a gram – or microgram – millionth of a gram – range).

### **Why do we need vitamins?**

We need vitamins because the body uses them to regulate many vital activities of the cells that make up our tissues. These activities include the regulation of energy metabolism, the healing of wounds, the fighting off of infection, and the control of the decoding of our DNA blueprints for the cellular machinery needed to regulate cell growth, differentiation, and retirement.

### **Is there more than one form of vitamin D?**

There are two main forms of vitamin D, called, respectively, ergocalciferol and cholecalciferol. Ergocalciferol is also known as vitamin D<sub>2</sub>, and cholecalciferol as vitamin D<sub>3</sub>.

### **Where do I get vitamin D?**

The principal source of vitamin D is from our own skins. A chemical compound called 7-dehydrocholesterol, naturally present in the superficial layers of skin, is converted, on exposure to UV-B radiation, to a compound called pre-vitamin D, which spontaneously changes into cholecalciferol (vitamin D<sub>3</sub>). However, we manufacture this vitamin D only if we expose our skins to UV-B radiation. If we spend all of our time indoors, or go out only in the early morning or late evening, then we simply do not get enough ultraviolet radiation to make our own vitamin D. Furthermore, in individuals who use sunscreen extensively or who are heavily pigmented, the UV radiation is blocked, which reduces the ability to manufacture our own vitamin D. Also, those who live in northern latitudes have less chance to make vitamin D, since in wintertime, even at mid-day, the sunlight is so weak as to preclude significant vitamin D synthesis in our skins.

There is also some vitamin D available in food, but, unlike the other vitamins, most foods do not contain appreciable amounts of this micronutrient. The few exceptions would be oily fish that are wild caught (and hence lived on top of the ocean's food chain), and possibly some other animal meats (but only if the animals concerned have been reared outdoors and have made their own vitamin D). All such "natural" sources of vitamin D provide only cholecalciferol, vitamin D<sub>3</sub>. Vitamin D<sub>2</sub> is rarely found in nature. A few mushrooms may contain some vitamin D, and if they have been dried in the sun, their vitamin D content may be appreciable. This mushroom vitamin D is ergocalciferol (vitamin D<sub>2</sub>).

### **How long should I be outdoors, and how much skin should I expose?**

There is no single right answer. But a light-skinned person, wearing a bathing suit, will make about 15,000 IU of vitamin D in 15–20 minutes in July at mid-day. Darker skinned individuals can do the same, but it can take much longer.

### **What about skin cancer? Should I use sun screen?**

The short exposures needed to produce vitamin D are not enough to cause skin cancer. However, if you are worried about that risk, apply sun screen after the first 15 minutes' exposure. Note: sun screen, when used as directed, completely blocks vitamin D synthesis in the skin. So you should not use it all the time unless you have a photo-sensitivity dermatitis.

### **Does vitamin D act in its native form, or does the body have to "process" it before it becomes active?**

The body converts vitamin D, whether taken by mouth or made in the skin, to a compound called 25-hydroxyvitamin D [25(OH)D]. This compound circulates in the blood and is the way physicians or scientists can assess vitamin D status. High levels of serum 25(OH)D indicate that the individual concerned is getting enough vitamin D, while low levels indicate deficiency. 25(OH)D is the principal storage form of the vitamin. It has a long lifetime in the body and is not very active in its own right. However, the body converts up to 100 micrograms of 25(OH)D each day into a further compound called calcitriol, which is the actual chemical form of the vitamin that helps the body signal the decoding of the DNA blueprints for over 200 human genes.

The body also uses calcitriol to signal the lining of the intestine to absorb calcium more efficiently, thus helping us get by on typical calcium intakes. The calcitriol that acts in this way is synthesized in the kidney from the pool of 25(OH)D in the blood, in response to signals from the parathyroid glands; it circulates in the blood, from which it acts on the intestinal lining cells to cause them to produce a calcium transport protein that helps shuttle calcium from the digesting food into the blood. By contrast, the calcitriol that the body tissues use to control their own proliferation and differentiation is synthesized right within the cells concerned. This synthesis is in response to signals specific to each tissue. The calcitriol circulating in the blood (which signals intestinal absorption of calcium) is typically too little to ensure optimal responses for this intracellular activity of the vitamin.

## **What happens if I don't get enough vitamin D?**

In its most extreme form vitamin D deficiency manifests itself in childhood as a disease called rickets, and in adults as a disease called osteomalacia. The two disorders are essentially identical except for the fact that growth is disrupted in childhood and the bones become malformed. But at the level of bone tissue itself, the two are indistinguishable. The bones become softer than normal because the concentration of minerals in the blood stream is no longer adequate to support the mineralization of new bone. This deficiency, in turn, comes about because efficient calcium absorption requires the presence of vitamin D, and as the body tries to compensate for low calcium absorption, it increases the secretion of a hormone from the parathyroid glands which increases the urinary loss of phosphorus, thereby lowering the phosphorus concentration of the blood. In brief, in the absence of sufficient vitamin D, the body is not able to absorb enough calcium, and the blood doesn't contain enough phosphorus, and since bone mineral consists of calcium phosphate, this double deficiency leads to an inability to form properly mineralized bone.

Milder degrees of deficiency are now understood to be one of the causes of a vast array of chronic diseases, including osteoporosis, impaired immune competence, various of the autoimmune diseases (such as diabetes and multiple sclerosis), as well as several cancers (breast, colon, lung, lymphoma, and prostate, among others), high blood pressure and cardiovascular disease. All may develop because of, or be exacerbated by vitamin D deficiency. All of these diseases have many other causes as well, and vitamin D deficiency probably acts by making us more susceptible to the causes of cancer, hypertension, infection, etc. Asking the body to deal with these disorders in the presence of vitamin D deficiency is like asking a fighter to enter battle with one hand tied behind his back.

## **How much vitamin D do I need?**

The body needs about 4000 IU per day in order to maintain a healthy concentration of 25(OH)D in the blood. Most of us don't get that much; even so, most of what we do get seems to come from casual exposure of the skin to sunlight. The foods, fortified foods, and supplements we typically consume generally provide no more than 150–250 IU each day, on average. Because most of us don't get enough sun exposure, the combination of what sun we do get, plus the vitamin D that we take by mouth, generally totals no more than 2000–3000 IU/day. Thus, in order to meet the body's need for about 4000 IU/day, most adults in North America need to take a supplement providing somewhere in the range of 800–2000 IU/day.

## **Is vitamin D safe?**

Yes, if it is consumed in reasonable quantities (such as those cited above). However, vitamin D is an extremely potent compound, and if given in high enough doses, can produce severe toxicity leading even to death. Current best estimates indicate that doses of up to 10,000 IU/day are safe for virtually all adults. Very few individuals need anything remotely close to that dose, so it is comforting to know that there is a margin of safety between what we ought to be taking by mouth, and the level that might produce harmful effects.

### **How can I tell if I need vitamin D?**

The chances are you do. Most adults in North America or Europe need extra vitamin D. A recent, informal survey of the principal clinical scientists working in the vitamin D field revealed that everyone of them, to a person, takes vitamin D supplementation, in doses ranging from 1500 IU/day to over 4000 IU/day.

But if you want to know for certain, ask your physician to request a blood test for serum 25(OH)D. Most clinical investigators would recommend that the result be 32 ng/mL or higher. (Values up to as high as 200 ng/mL are safe, and it is instructive to know that outdoor summer workers, at the end of summer, will typically have a value of 50–60 ng/mL.)

### **Are vitamins D<sub>2</sub> and D<sub>3</sub> equally effective?**

No. Vitamin D<sub>3</sub> is substantially more potent than vitamin D<sub>2</sub>. In the early days of vitamin D research, the only way to evaluate these compounds was to examine their ability to prevent rickets in experimental animals. That was a pretty crude assay, and one couldn't tell the difference between the two forms of the vitamin. So they were assigned the same number of units (IUs) per milligram. But now that we have the serum 25(OH)D to measure, we understand that vitamin D<sub>3</sub> may be anywhere from four to 10 times more potent than vitamin D<sub>2</sub>. Furthermore, vitamin D<sub>3</sub> is the natural form, typically made in our bodies if we give them the chance to do so, and hence taking vitamin D<sub>3</sub> by mouth is more “natural” than taking vitamin D<sub>2</sub> (which is a purely synthetic product except, as noted above, from what we might get from sun dried mushrooms).

### **Is it important to take vitamin D with food?**

No, vitamin D can be taken virtually anytime, with or without food. In fact, so long as the total dose is sufficient, vitamin D doesn't even have to be taken every day. Some physicians prescribe once weekly dosing, and some studies have been published with doses once every four months. In brief, unlike most medicines, vitamin D does not have to be taken in any particular fashion. The important thing is to achieve and maintain a normal level of 25(OH)D in the blood.

### **How do I know if I am taking too much?**

You can tell you're getting too much in the same way that you can tell whether you're getting enough, that is by measuring the blood concentration of 25(OH)D. But that is seldom necessary, as the doses discussed elsewhere in these FAQs would never produce toxicity, even if you're taking them in combination with fortified foods. There have been no reported cases of vitamin D toxicity at serum levels of 25(OH)D below 200 ng/mL.

## **Why are the published requirements for vitamin D so much lower than the levels mentioned in these FAQs?**

The current requirements were set in the mid 1990s, before we knew most of what we now understand about vitamin D, for example how much the body uses every day. In brief, these recommendations are outdated. Furthermore, they were intended solely to prevent rickets and osteomalacia. And they are adequate for that purpose. But current recommended intakes, if they were to provide the only vitamin D the body got, would not be adequate for total body health.

## **How long is vitamin D stored in the body?**

Vitamin D is a fat soluble chemical compound and when present in large quantities, it is stored in body fat. It can reside there for months, gradually being released into the blood stream. But at prevailing intakes there probably is little or no storage of vitamin D *per se*. It appears to be converted almost immediately to 25(OH)D, which circulates in the blood and is relatively rapidly used. If I take in more vitamin D today than my body needs today, then I will store the excess. Chances are, there will be days when I will not be getting as much as I need. So some storage seems a good idea. For example, outdoor summer workers get more than they need every day from the sun, but by the end of winter, they have used up all their reserves and are typically in a state of mild deficiency.

## **Is it better to take vitamin D separately, or as part of another supplement (such as a calcium tablet or a multivitamin)?**

No, it's not better, but you will generally need to take more vitamin D than you can get in the available combinations. Usual calcium tablets contain 200–400 IU, and multivitamins usually contain no more than 400 IU. Most individuals will need an additional 800 to 1000 IU/day, over and above what they may now be getting from combination products and fortified foods.

## **How do I know what kind of vitamin D is in my combination tablet/capsule?**

Usually the label will say, using words such as “vitamin D<sub>3</sub>” or “cholecalciferol”. If the label doesn't tell you, ask the pharmacist to look it up for you. If he/she can't get that information, ask the manufacturer – or switch to a product that gives you the information you need.

## **Do vitamin D supplements expire?**

Yes, an expiration date will be printed on the label. Look for it and use it while it is fresh. By “expire” what is meant is that it loses some of its potency. If you use expired vitamin D, you won't be harmed; but you may no longer be getting as much as the label says.