

Vitamin D Activates Two Key Immune Systems

Landmark findings show why the “sunshine-and-seafood” vitamin is increasingly seen as critical to defense against infection

by Craig Weatherby

New findings from Denmark affirm and expand the role that vitamin D plays in our bodies’ most sophisticated immune response to infectious agents.

And they follow an important discovery reported last year from Oregon State University (OSU), which confirmed vitamin D’s essentiality to humans’ first-line immune response to disease microbes.

Let’s take a look at both of these closely related studies, starting with last year’s OSU investigation.

Vitamin D’s role in the first-line defense against disease microbes

The human body responds to disease-causing microbes—bacteria, viruses, and other “pathogens”—by using two distinct but partly overlapping aspects of its immune system.

The “innate” immune system is first line of defense against bacteria, viruses and other pathogens. It is ancient in evolutionary terms, dating back some 60 million years to our pre-human primate ancestors.

(The more recently evolved “adaptive” immune system—which was the subject of the new vitamin D findings from Denmark—reacts to and remembers specific microbes to provide a more targeted, potentially more effective defense.)

The innate immune system—which employs proteins called consists of proteins call “anti-microbial peptides”—recognizes that something that probably doesn’t belong in the body, even though the specific pathogen may never have been encountered before.

Last August, researchers from OSU reported their discovery that the ability of vitamin D to regulate the innate immune system’s anti-microbial peptides is so important that is has been conserved through almost 60 million years of evolution (Gombart AF, Saito T, Koeffler HP 2009).

The Oregon team also noted that the vitamin D-regulated innate immune system is unique to primates, including humans, and occurs in no other known animal species.

They believe that this vitamin-D-mediated immune response must be critical to primates’ survival, or it would not have been retained through millions of years of natural selection.

Last year, the Oregon team found a new genetic element that allows vitamin D to boost the innate immune response by activating antimicrobial peptides.

And if the peptides suppress a pathogen effectively, this may help prevent the adaptive immune system from overreacting.

Key Points

- Gene study affirms and details vitamin D’s key role in the body’s sophisticated “adaptive” immune system, which remembers and targets specific pathogens.
- Findings follow affirmation of vitamin D’s role in activating anti-microbial proteins of the less targeted but still essential “innate” immune system.
- Immune system proteins activated by vitamin D also play key roles in cell and blood vessel growth, wound healing, and in the skin and digestive organs.

(It had already been known that vitamin D prevents the adaptive immune system from overreacting, thereby reducing counterproductive inflammation.)

As OSU professor Adrian Gombart said last August, “It's essential that we have both an innate immune response that provides an immediate front line of defense [and] protection against an overreaction by the immune system, which is what you see in sepsis and some autoimmune or degenerative diseases. This is a very delicate balancing act, and without sufficient levels of vitamin D you may not have an optimal response with either aspect of the immune system” (OSU 2009).

He described the history and importance of vitamin D in innate immunity in a 2009 review article that's worth quoting at length:

- “Vitamin D deficiency has been correlated with increased rates of infection. Since the early 19th century, both environmental (i.e., sunlight) and dietary sources (cod liver) of vitamin D have been identified as treatments for TB.
- “The recent discovery that vitamin D induces antimicrobial peptide gene expression explains, in part, the ‘antibiotic’ effect of vitamin D and has greatly renewed interest in the ability of vitamin D to improve immune function.
- “Subsequent work indicates that this regulation is biologically important for the response of the innate immune system to wounds and infection and that deficiency may lead to suboptimal responses toward bacterial and viral infections” (Gombart A 2009).

And as Dr. Gobart explained in a press release, the anti-microbial peptide activated by vitamin D plays other key roles in human health:

“The [vitamin D-activated] antimicrobial peptide that we're studying seems to be involved not just in killing bacteria... It recruits other immune cells and sounds the alarm that something is wrong. It helps promote development of blood vessels, cell growth and healing of wounds. And it seems to have important roles in barrier tissues such as skin and the digestive system” (OSU 2009).

Now, let's turn our attention to the new study from Denmark, which concerns vitamin D's role in the more sophisticated, powerful—and potentially self-destructive—“adaptive” immune system.

New genome study details vitamin D's key part in the “modern” immune system

Danish scientists say they've discovered that vitamin D is crucial to activating the adaptive immune system, which evolved later than the innate immune system.

Their study focused on the “T cells” of the adaptive immune system, which, to be effective, must first be triggered to transform into “killer” or “helper” cells

Killer T cells seek out and destroy pathogens, while helper T cells “remember” the pathogen so that the body will mount a more efficient immune response should it reappear in the future.

The Danes' landmark study demonstrates that T cells rely on vitamin D to activate and remain dormant if vitamin D is lacking in the blood.

According to lead author Carsten Geisler, Ph.D., “We have discovered that the first stage in the activation of a T cell involves vitamin D.”

When a T cell is exposed to a pathogen, the contact initiates a biochemical reaction that prompts the cell to extend the

signaling device or 'antenna' known as a vitamin D receptor

Unless a T cell's receptor encounters vitamin D, its full transformation into an effective killer or helper cell will cease ... and this is why the Danes' achievement constitutes a major breakthrough.

As Dr. Geisler said, "Scientists have known for a long time that vitamin D is important for calcium absorption and the vitamin has also been implicated in diseases such as cancer and multiple sclerosis, but what we didn't realize is how crucial vitamin D is for actually activating the immune system - which we know now."

Danish findings hold practical implications

The Danes say that they believe their discovery may help doctors enhance patient's immune responses and deal with autoimmune diseases and reduce rejection of transplanted organs.

Active T cells multiply at an explosive rate and can create runaway inflammation with serious, and sometimes—as in the state of sepsis that can follow a major infection—even fatal consequences.

And after an organ transplant, T cells may attack the donor organ as a foreign invader.

In an autoimmune disease such as rheumatoid arthritis or lupus, T cells mistake fragments of the body's own cells for foreign pathogens, leading them to attack the body's own tissues.

The Danish team was able to track the steps by which an inactive T cell changes into an active cell... a breakthrough that may allow doctors to intervene at several points to influence the body's immune response.

The findings, said Professor Geisler, "...could help us to combat infectious diseases and global epidemics. They will be of particular use when developing new vaccines, which work precisely on the basis of both training our immune systems to react and suppressing the body's natural defenses in situations where this is important—as is the case with organ transplants and autoimmune disease."

Most vitamin D is produced when UV sunrays strike the skin. The only good dietary sources are supplements and certain foods: especially fatty fish such as salmon, tuna, sardines, sablefish, and mackerel.

Sources

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