The sunshine vitamin

A little exposure to sunlight is all it takes to stock up on Vitamin D, says **S Ananthanarayanan**

VITAMIN D is a trace nutrient that we need to help form and maintain bones as well as many other important body functions. It is not there in good quantity in most foods but is produced abundantly when we expose ourselves to the sun.

A recently released book, *The Vitamin D Solution — 3 short steps to improved health*, by Michael F Holick, MD, PhD, professor of medicine, physiology and biophysics at Boston University Medical Centre, collects together the current knowledge about Vitamin D and tells the story of how the knowledge came to us. It also spells out simple steps to take the right foods, supplements and exposure to the sun to keep up our Vitamin D levels for health and vitality.

The vitamin

Vitamins were discovered in the course of studying the diseases that arise due to their absence. The diseases scurvy and beri-beri were found to respond to changes in diet and analysing these changes helped identify Vitamins C and B. These disease-preventing substances, present in traces, were not proteins, fats or carbohydrates, the known components of the body. Nor were they minerals. They were hence a new class of nutrients, first named Vitamines, combining "vital" with "amine" as they were thought to be amines, the name shortened to vitamin when it was found that they were not, in fact, amines.

Vitamin D was discovered while studying rickets, a disease affecting bones, which was rare till the 1700s and this continued as a serious public health issue till the early 1900s. Scientists began to search for the specific additions to diet that could prevent rickets — in the manner that citrus fruit had helped scurvy and unpolished rice had helped control beri-beri. It was soon found that cod liver oil was an effective remedy and a preventive. It was also found that simply exposing the body to sunlight was equally effective, in fact even just some foods that had been exposed to sunlight!

The effective agent in the control of rickets was identified as Vitamin D in the 1920s and now there are methods to recover and package this vitamin to supplement common foods or for the treatment of acute deficiency.

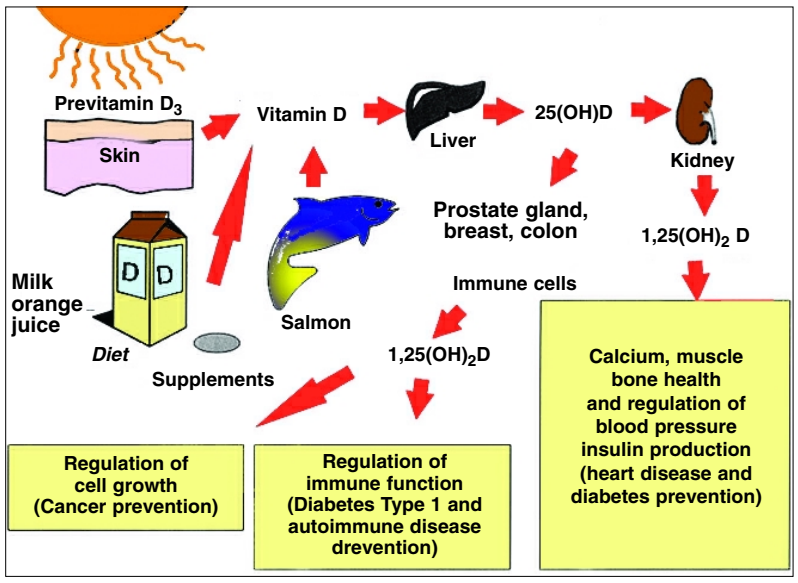
A substance is called a vitamin when the organism itself cannot synthesise it from its components and depends on diet or external sources. And a substance that is a vitamin for one organism may not be so for another. Like ascorbic acid, Vitamin C, is important for humans but not for many animals.

By this understanding, Vitamin D may be a vitamin but, in fact, it is more correctly called a hormone, or even a precursor to a hormone. Hormones are substances produced by cells of an organism to signal to other cells to act in different ways. All cells in the body are found to have the capacity to identify the Vitamin D signal and react in many ways. The other difference between Vitamin D and a true vitamin is that the body can, in fact, produce Vitamin D on its own and is not entirely dependant on external sources.

Mechanism

The two main components of Vitamin D are Vitamin D_2 and D_3, known together as *Calciferol*. Vitamin D_2 is made by non-vertebrate animals, fungi and plants in response to UV radiation. Why these organisms need it is not clear, but a property of Vitamin D_2 is that it can absorb UV radiation and protect organisms like a sunscreen.

Vitamin D_3 is made by vertebrates on exposure to UV radiation, in the skin, by a derivative of cholesterol that the skin contains. In some animals, fur or feathers may block sunlight from reaching the skin. Vitamin D is then generated from oily secretions that are deposited on the fur or feathers and then ingested by the animal when it grooms itself. In fact, the method of drug companies to manufacture Vitamin D supplements is to collect the oily substance from the fur of animals, like *lanolin* from sheep, and expose it to sunlight!



A schematic view of sources of Vitamin D3 and Its role in maintaining health and preventing multiple deadly and debilitating diseases, including cancer, hypertension, cardiac disease, diabetes, osteoporosis, multiple sclerosis, psoriasis, asthma, allergies and depression, among many others.

Professor Michael Holick.

The substance produced at the skin is still only a pre-Vitamin D and it needs to be activated by action of the liver and kidneys to become the biologically active forms. The active Vitamin D is then secreted from the kidneys and it builds up in target areas like the intestines — where Vitamin D enables the taking up of calcium from food. Too little Vitamin D leads to a drop in calcium levels in the blood and different ailments, mainly affecting the bones — osteoporosis, osteomalacia and rickets, the last a disease where the bones become soft and get deformed, accompanied by muscle spasms and seizures.

The generation of Vitamin D in the skin needs UV radiation in sufficient quantity, which is easily obtained in the tropics but hardly at all in the Arctics. Light-coloured skin is also better adapted to Vitamin D formation, which is well for the light-skinned races in temperate countries. The fact that much of Europe started living in cities, where they stayed out of the sun most of the day, after the 18th century and also the use of coal for heating and steam, which darkened the sky, may account for why rickets became rampant after the 1700s.

Vitamin D solution

Dr Michael F Hollick, who has studied Vitamin D for more than 30 years, describes in his book how every body cell has a receptor for the vitamin it does much more than only promote bone health. Keeping up levels of Vitamin D can treat, prevent and even reverse a surprising number of daily ailments from high blood pressure to back pain, alleviate symptoms of chronic diseases like diabetes and arthritis and actually prevent infectious diseases, including H1N1 and cancer. Vitamin D is found to affect such a variety of organs that Dr Holick credits it with improving infertility, weight control, memory and moods!

The writer can be contacted at simplescience@gmail.com

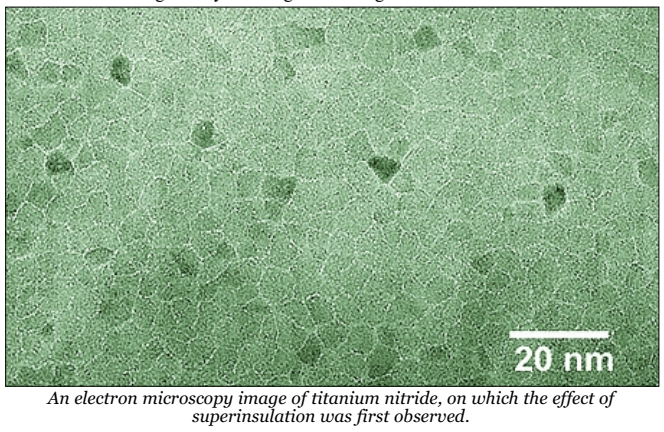
Esoteric superinsulators

Quantum phenomenon may lead to new batteries and electronic circuits, says **Saswato R Das**

IN another reminder that matter at cryogenic temperatures can behave in totally unexpected ways, a team of physicists led by Valerii Vinokur at Argonne National Laboratory in the USA has stumbled upon a new phenomenon that they say can lead to improved batteries and new types of electronics and supersensitive sensors. Vinokur is calling the new phenomenon superinsulation, and has recently worked out a basic theory to try to explain why it occurs.

In many ways, superinsulation is the opposite of superconduction — the now relatively well understood phenomenon whereby materials lose resistance to the flow of electricity at very low temperatures. Superconductors have found all sorts of applications — from particle accelerators to MRI machines to magnetically levitating trains. In superinsulators, on the other hand, the resistance to the flow of electricity becomes infinite, preventing any flow of electric current.

Superinsulators were discovered in April 2008 by Vinokur and Russian scientist Tatyana Baturina in titanium nitride that had been chilled to a temperature bordering on absolute zero by a dilution refrigerator. When the physicists tried to send a current through a thin film of super-cooled titanium nitride, they found that the resistance increased suddenly by a 100,000-fold. The effect happened below a certain temperature and disappeared at higher temperatures. They also noticed that the effect was dependent on the strength of any associated magnetic field — it disappeared when the magnetic field strength increased.



An electron microscopy image of titanium nitride, on which the effect of superinsulation was first observed.

Vinokur and his colleagues realised that the new effect could be harnessed to form better batteries. In most batteries, there is a certain amount of leakage when the battery is left exposed to air since air is not a perfect insulator. Thus, an unused battery eventually drains — whether in days or weeks depends on the battery.

"If you pass a current through a superconductor, then it will carry the current forever; conversely, if you have a superinsulator, then it will hold a charge forever," he says.

Vinokur points out that a superconductor and a superinsulator could be engineered such that a device could have no heat losses. "It can be in either of the two states — superconducting or superinsulating — and in both states the Joule losses are zero. This kind of devices did not exist before," he says. Other than better batteries, he envisions that "superinsulators will become the basis of a new class of supersensitive sensors".

Vinokur, Baturina and Nikolai Chtchelkatchev, another Russian physicist, have worked out a microscopic theory of superinsulation which they published in a recent issue of *Physical Review Letters*. They say that superinsulation, like superconductivity, is caused by electrons that form pairs known as Cooper at low temperatures. In a superconductor, the pairs move together collectively, which means that there is no resistance to impede the flow of current. In a superinsulator, on the other hand, the Cooper pairs repel one another, and thus prevent any current from flowing.

Vinokur says that while the qualitative picture of the phenomenon emerged in 2008, it was only recently that the team succeeded in working out the initial detailed calculations.

Argonne scientist Valerii Vinokour (left) with Russian scientists Tatyana Baturina (centre) and Nikolai Chtchelkatchev, who discovered why the superinsulators are so good at blocking electric current.

Eugene Chudnovsky, an expert on superconductivity and a physics professor at Lehman College of the City University of New York, said the nature of superinsulators had been hotly debated by physicists and this was promising work.

So far, the theory and experiments have been confined to thin films of titanium nitride, says Vinokur, who intends to investigate other compounds at higher temperatures next. "There are plenty of still unresolved questions. We can only remind (ourselves) that the microscopic theory of superconductivity appeared almost 50 years after the discovery," he says.

The writer is based in New York and can be contacted at saswatodas@gmail.com

History of resistance

Tapan Kumar Maitra sketches the development of immunisation by tracing the hidden links between ancient and modern practices

THE term immunity usually means resistance of the body to pathogenic microbes, toxins or other kinds of foreign substances. It is a complex of physiological defence reactions which determine the relative constancy of the internal medium of the macro-organism, hinder the development of the infectious process or intoxication, and are capable of restoring the impaired functions of the organism.

In the process of evolution, organisms have developed the property of distinguishing "self" and "non-self" very accurately, which is just what protects them from being penetrated by foreign proteins, including pathogenic micro-organisms and heterogenic transplants. The "non-self" is detected by the lymphocyte receptors.

Insusceptibility to infectious diseases depends on many factors grouped under resistance and immunity. Resistance is the insusceptibility of the body to the effect of pathogenic factors. It embraces a wider group of phenomena of insusceptibility other than immunity. Non-specific resistance is the insusceptibility of the body to injury by pathogenic factors: mechanical (traumas, rocking), physical (barometric pressure, cooling, overheating, radiation energy, ionising radiation), chemical (oxygen deficiency, excess of carbon dioxide, action of poisonous substances, drugs, poisons of a chemical and bacterial origin) and biological (pathogenic protozoa, fungi, bacteria, rickettsiae and viruses.)

There may be resistance of the entire body and of its separate systems, although mutual dependence of both exists. Resistance is associated with the anatomical-physiological characteristics of the body, development of the central nervous system and endocrine glands. It depends on the phylogenetic development of the animal, individual and functional state of the body, and in man on social factors. Mental traumas predispose to somatic and infectious diseases; chronic hunger and vitamin deficiencies lead to decline in resistance; intoxication by alcohol, opium, cocaine and other narcotics has a negative effect on human resistance.

Modern research has revealed that immunity also protects from genetically heterologous cells and tissues.

In the traditions associated with the ancient tribes considerable allowance was made for preventive measures including vaccines against various diseases. Thus, for example, the inhabitants of East Africa successfully used vaccinations against snake bite. They used snake venom as a vaccine contained in a paste form. This, applied to cross-like scarifications on the skin caused a prolonged inflammation and on being absorbed gradually helped in producing immunity. Repeated vaccinations were made over a period of several years. Africans produced an artificial immunity to tick-borne relapsing fever by natural immunisation. They carried on their body ticks that contained a virus for a long time.

Inhabitants of Mauritania (Western Africa) protected their herds from epizootic peripneumonia of cattle by vaccinations (skin cuts) with the aid of a dagger that was dipped in the lung of a bull which had died from peripneumonia. This method became known in Europe in 1773 and was widely employed by cattle farmers in England and Holland.

In South-East Asia, at around 2000-3000 BC, children were vaccinated against smallpox. The Iranians inoculated into skin cuts smallpox scabs which had been dried and ground to powder. The Cherkesses and Georgians made intradermal injections with needles moistened with smallpox infectious material.

Folk methods of reproducing insusceptibility to infectious diseases by contamination, however, were not always successful. Quite often typical diseases developed after such vaccination. In the remote ages it was the custom to make children with scratches on their hands milk cows infected with cowpox to rid them of smallpox. This method was also known long ago in England, France and Germany.

E Jenner came to learn these folk methods of vaccinations from peasants. For 25 years he checked his observation, and in 1798 published his discovery. However, within 100 years after Jenner's work, immunology considerably enriched its own methods thanks to L Pasteur.

Pasteur and his pupils discovered a method of weakening the causative agents of chicken cholera, anthrax and rabies and confirmed the possibility of using them for specific immunisation. Attenuated microbes received the name of vaccines, while the method itself became known as vaccination (immunisation).

During the last 90 years, the problems of immunity have acquired not only a medical, but also a general biological significance. Immunological methods have been used to determine infectious diseases in forensic medicine, sanitary-hygienic practice, production of highly effective preparations used in therapy, prophylaxis of infectious diseases as well as in establishing evolutionary and genetic links among plant and animal species.

As a result of numerous investigations in the field of immunity, the main principles of acquired immunity were formulated in accordance with the works of Pasteur, Metchnikoff, Ehrlich and other scientists. Metchnikoff founded the biological theory of immunity as a system of defence reactions, formed in the process of evolution of the animal world in the struggle for existence and natural selection.

The current period of development of immunology is characterised by the mechanisms of immunity considered as an aggregate of all the physiological defence reactions of the macro-organism. They have greatly expanded over the last 20 years due to the information gained from molecular biology and genetics. The research conducted by P Medawar and other immunologists has established that immunity protects the organism not only from micro-organisms, but also from genetically heterologous cells and tissues.

The writer is Associate Professor and Head, Department of Botany, Ananda Mohan College, Kolkata