Here's to embracing the sun

THE ETERNAL PROVIDER, IS FOUND TO BE A PROTECTOR TOO, WRITES S ANANTHANARAYANAN

The Earth's ecosystem is a built around the need for adaptation in order to use energy from the sun. While physical features, mountains, oceans or the seasons, have settled into a rhythm, the Earth's vegetation has evolved to capture and store the sun's energy. The diversity of the animal kingdom has then organised itself to exploit, directly or indirectly, these plant and vegetable resources.

Animals, however, also bypass the plant intermediary and sometimes use the sun's bounty by themselves. The simplest instance is in the use of light for vision. A more specialised one is the absorption of sunlight energy through the skin of animals, which becomes the power source for synthesis, primarily of vitamin D.

Yet another instance has now emerged, of supporting the immune system, and this has been detailed in the *Nature* group journal, *Scientific Reports*, by Thieu X Phan, Barbara Jaruga, Sandeep C Pingle, Bidhan C Bandyopadhyay and Gerard P Ahern, of Georgetown University and the Veteran Affairs Medical Centre, both in Washington, and the department of biology, Vinh University, Vietnam.

The role of sunlight in the synthesis of vitamin D is well known and it is the ultra violet part of the spectrum, in sunlight, that is effective. Therefore, we need direct sunlight at preferably midday, and on the skin.

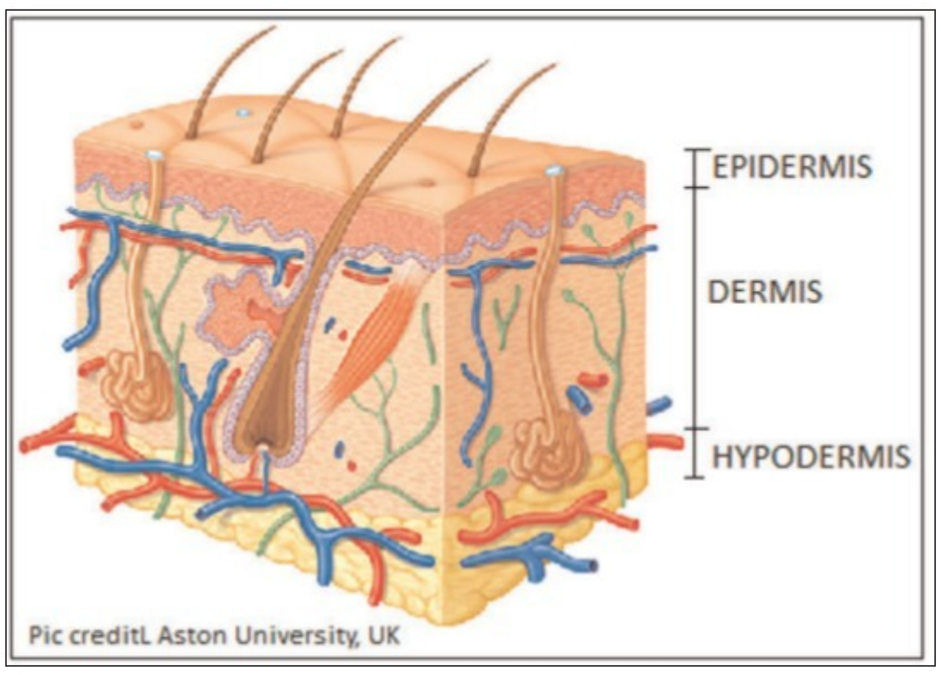
THE WONDER VITAMIN

Not enough vitamin D is a cause of many medical conditions — depression, asthma, high blood pressure and heart disease, diabetes, bowel disease, arthritis, cancer, flu, TB, and then muscle and bone ailments. The only dietary sources are fish, milk and eggs and even when derived from these, the vitamin needs to be converted into a useful form by the liver cells.

In contrast, vitamin D, which is produced by the skin when bathed in sunlight, is abundant and also more readily processed in the liver.

The first casualty of vitamin D deficiency is a skeletal frame — rickets and osteoporosis. Deficiency can be treated with injections and oral supplements, tablets and sachets, taken for a few months.

But 20 minutes in direct sunlight, with as much of the skin exposed as possible, would be quicker and more effective, and cheaper. The benefits would be a general increase in vitality and saving the cost of treating fractures, especially in the aged, apart from the cost of the care giver and working days lost.



Pic creditL Aston University, UK

Rays from the slanting sun during winter months in the northern countries, for instance, are not useful, which is why people in those countries rush to the beaches in summer.

The manufacture of vitamin D takes place in the inner parts of the thin, outer layer of the skin called the epidermis. Near ultra violet — or light only a little past the blue side of the visible spectrum -- is able to penetrate to this part of the skin. These photons are a little more energetic than those of visible light and they convert 7-dehydrocholesterol, a form of cholesterol and a major component of body cells, into a precursor of vitamin D, which changes to vitamin D within about a day. There is ample supply of cholesterol and a short exposure to bright sunlight is all it takes to for a person to generate a day's requirement of vitamin D. It thereafter plays an important role in the body, by enabling the absorption of calcium and strengthening the bones and similarly several other processes including the immune system.

While plants generally do not produce vitamin D, the earliest source was phytoplankton in the sea over 500 million years ago. That was the source of vitamin D for early, ocean bound vertebrates, but land-based animals needed their own source to sustain their calcium-rich skeletal structure. Vitamin D synthesis using sunlight has therefore been around for 350 million years.

What the Washington and Vietnam based group has discovered is yet another role of the sunlight that gets past the outer layer of skin.

The layer just below the epidermis, called the dermis, is rich in T cells, which are an important part of the immune response of the body. T cells are abundant in the skin, which contains, in fact, twice the number of those in the blood stream. This may be just as it should be, as the skin is the body's largest organ and the gateway used by myriads of microbes. T cells are either "helper" T cells, which enable the action of other parts of the immune system, or they are "killer" T cells, which destroy virus infected or tumorous cells. And then there are memory T cells, which persist with a record of specific antigens even after a first attack has been overcome.

What the researchers have discovered is that sunlight, which gets through to the T cells, has the effect of increasing their motility or movement.

As T cells, which act against infection, need to move to the site of infection, an increase in their capacity to move is an increase in their capacity to maintain body immunity. While the epidermis is opaque to ultra violet light, blue light, which is the part of the spectrum just below ultra violet, is able to get through and reach the part that is rich in T cells. The *Scientific Reports* paper notes that blue light passes through the dermis and is reflected back by the blood vessels. So the inner layer of the skin is doubly bathed in blue light.

That apart, the study notes that the T cells in the dermis being affected by blue light amounts to a whole new type of photo-sensitive cell, apart from the rods and cones of the eye. The researchers found that T cells contain the same components that are found in the cells of the retina, which are light sensitive. Laboratory trials with T cells then showed that the cells were sensitive to UV and blue light, responding with generation of hydrogen peroxide, which leads to higher levels of calcium ions — they are important carriers of signals within and between cells. It is the change of calcium ion concentration that brings about contraction of muscles, and in T cells, irradiation with blue light led to changes in shape and faster random movements of the cells.

Hydrogen peroxide is also the substance that white blood corpuscles release to trigger immune response when they sense infection. "It all fits together" Ahern, from Georgetown University is reported to have said.

Exposure to sunlight is already celebrated for production of vitamin D, and to be more effective than the use of dietary supplements. What we now have is a mechanism by which sunlight promotes the immune reaction of the body, and one more reason for each one of us to go out in the sun. There is a great deal of needless suffering and health care expense that could be avoided if people systematically made sure that they get a short, daily dose of sunshine.

THE WRITER CAN BE CONTACTED AT
response@simplescience.in

FACILITATING MOVEMENT

TAPAN KUMAR MAITRA EXPLAINS THE FUNCTIONING OF TRANS-MEMBRANE PROTEIN CHANNELS

While some transport proteins facilitate diffusing by functioning as carrier proteins that alternate between different conformational states, others do so by forming hydrophilic trans-membrane channels that allow specific solutes — mainly ions — to move across the membrane directly. Let's consider three kinds of trans-membrane protein channels — ion channels, porins, and aquaporins.

Trans-membrane proteins that allow rapid passage of specific ions are called ion channels. Despite their apparently simple design - just a tiny pore lined with hydrophilic amino acid side chains - ion channels are remarkably selective. Most allow passage of only one kind of ion, so separate channels are needed for transporting different varieties. This selectivity is remarkable given the small differences in size and charge among these ions. The underlying mechanism is not yet well understood; a reasonable hypothesis is that selectivity may involve both ion-specific binding sites and a constricted centre that serves as a size filter. The rate of transport is equally remarkable — in some cases, a single channel can conduct almost a million ions per second.

Regulation of ion movement across membranes plays an important role in many types of cellular communication. For example, the transmission of electrical signals by nerve cells depends critically on rapid, controlled changes in the movement of Na^+ (sodium) and K^+ (potassium) ions through their respective channels. These changes are so rapid that they are measured in milliseconds. In addition to such short-term regulation, most ion channels are also subject to longer-term regulation, usually in response to external stimuli such as hormones.

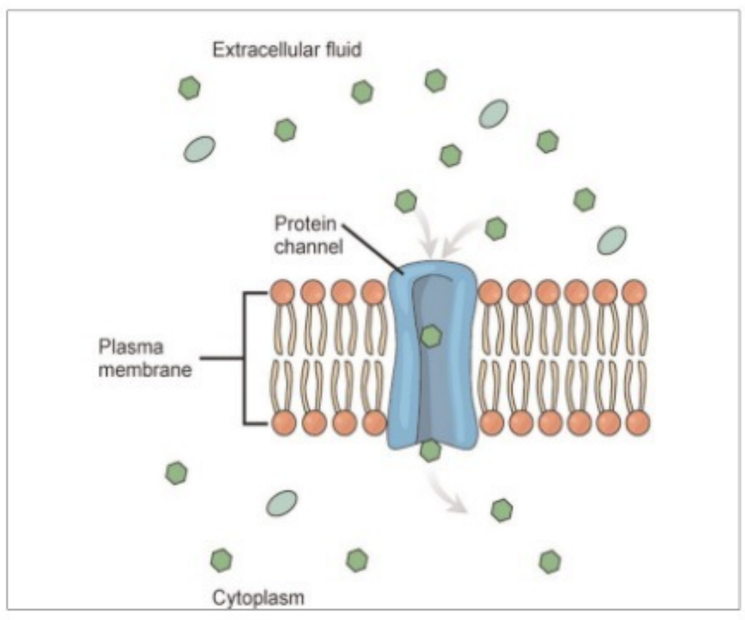
Compared with ion channels, the pores found in the outer membranes of mitochondria, chloroplasts, and many bacteria are somewhat larger and much less specific. These pores are formed by multi-pass trans-membrane proteins called porins. Bacterial porins are among the trans-membrane proteins whose structures have been determined by X-ray crystallography. A key feature revealed by this technique is that the trans-membrane segments of porin molecules cross the membrane not as an helix but as a closed cylindrical sheet called a barrel. The barrel has a water-filled pore at its centre. Polar side chains line the inside of the pore whereas the outside of the barrel consists mainly of non-polar side chains that interact with the hydrophobic interior of the membrane. The pore allows passage of various hydrophilic solutes, with the size limit for the solute molecules determined by the pore size of the particular porin.

For cells in at least some tissues, however, a specific kind of water movement is mediated by a family of channel proteins called aquaporins. Aquaporins do not account for all water movement across membranes. Instead, they facilitate the rapid movement of water molecules into or out of cells in specific tissues that require this capability. For example, the proximal tubules of kidneys reabsorb water as part of urine formation, and cells in this tissue have a high density of AQPs in their plasma membrane. The same is true of erythrocytes, which must be able to expand or shrink rapidly in response to sudden changes in osmotic pressure as they move through the kidney or other arterial passages. In plants, AQPs are a prominent feature of the vacuolar membrane, reflecting the rapid movement of water that is required to develop turgor.

Aquaporins may well be responsible for rapid transport of water in other cell types as well, but these are some of the better-characterised examples at present. Interestingly, prokaryotes appear not to contain aquaporins, probably because of their small size, and hence their large surface area/volume ratio, makes facilitated transport of water unnecessary.

All aquaporins described to date are integral membrane proteins with six helical transmembrane segments. In the case of AQP-1, the aquaporin found in proximal kidney tubules, the functional unit is a tetramer of four identical monomers.

The four monomers appear to associate side-by-side in the membrane with their 24 trans-membrane segments oriented to form a central channel lined with hydrophilic side chains.



THE WRITER IS ASSOCIATE PROFESSOR, HEAD, DEPARTMENT OF BOTANY, ANANDA MOHAN COLLEGE, KOLKATA, AND ALSO FELLOW BOTANICAL SOCIETY OF BENGAL AND CAN BE CONTACTED AT
tapanmaitra59@yahoo.co.in

At the heart of our world

SCIENTISTS IN JAPAN ARE CLOSER TO SOLVING THE IDENTITY OF THE MYSTERY ELEMENT IN THE EARTH'S CORE

Japanese scientists say that silicon is the likely mystery element in the Earth's inner core, claiming progress on solving one of the planet's deepest secrets.

Consensus has long been that the centre of the planet is composed of about 85 per cent iron and 10 per cent nickel, with sulphur, oxygen and silicon prime candidates for the other five per cent.

But geophysicist Eiji Ohtani at Tohoku University in northern Japan and his research team suggest that silicon is the most likely candidate. Ohtani's team conducted experiments on iron-nickel alloys mixed with silicon, subjecting them in the lab to the kinds of high temperatures and pressure found in the inner core.

It discovered that the data for the mixed material observed with X-rays matched seismic data — namely, sound velocity, or seismic waves — obtained for the inner core. "Our latest experiments suggest that the remaining five percent of the inner core is composed mostly of silicon," Ohtani told *AFP*. He said that the finding helps understand whether the Earth's surface was rich in oxygen in its early formation before photosynthesis began as oxygen has been another potential candidate for the mystery element in the Earth's inner core.

Ohtani cautioned that more work needs to be done to confirm his findings on silicon. Some scientists say that if the Earth's inner core contains silicon then it means the rest of the planet must have been relatively oxygen rich at the time of its formation, because oxygen that they believe existed when the planet was formed was not confined to the inner core.

But if the mystery element in the core is oxygen then the rest of the earth was oxygen-poor in the beginning. Ohtani said he does not think oxygen now exists in the inner core, citing the difficulty for silicon and oxygen to co-exist in the same place. "But it doesn't necessarily mean the rest of the planet was oxygen rich because there is a possibility that oxygen did not exist as an element of the earth at its formation in the first place", he said.

The earth is believed to be made up of three main layers — the solid outer layer where creatures including humans live, the mantle which is made up of hot magma and other semi-solid materials, and the core at the centre. The core comprises an outer layer of liquid iron and nickel, and an inner layer — a hot dense ball of mostly iron.

Ohtani presented his team's work at a meeting in December of the American Geophysical Union in San Francisco, and is preparing to submit a research paper to a peer-reviewed scientific journal. The presentation used a method similar to that applied by his team in a study published in February last year in the peer-reviewed journal *Science Advances*.

THE STRAITS TIMES/ANN

PLUS POINTS

Beautiful science

This is a region called NGC 6357 where radiation from hot, young stars is energising the cooler gas in the cloud that surrounds them. Located in a galaxy about 5,500 light years from Earth, NGC 6357 is a "cluster of clusters", containing at least three clusters of young stars, including many hot, massive and luminous ones.

This composite image contains X-ray data from Nasa's Chandra X-ray Observatory and the Rosat telescope (purple), infrared data from Nasa's Spitzer Space Telescope (orange) and optical data from the SuperCosmos Sky Survey (blue) made by the United Kingdom Infrared Telescope.

The X-rays from Chandra and Rosat reveal hundreds of point sources, which are the young stars in NGC 6357 and diffuse X-ray emission from the hot gas. There are bubbles, or cavities, that have been created by radiation and material blowing away from the surfaces of massive stars, plus supernova explosions.

Astronomers call NGC 6357 and others like it "HII" (pronounced "H-two") regions.

A HII region is created when the radiation from hot, young stars strips away the electrons from neutral hydrogen atoms in the surrounding gas to form clouds of ionised hydrogen, which is denoted scientifically as "HII".

THE STRAITS TIMES/ANN

Mimicking our language

Baboons make five distinct vowel-like sounds much like humans, according to new research, which suggests language began to evolve about 25 million years ago, much earlier than previously thought.

It was thought that baboons, a type of monkey, lacked the right kind of larynx to make such a range of sounds. However, an acoustical analysis of their grunts, barks, "wahoos", "yaks" and copulation calls found they were capable of remarkably human vocalisations. Writing in the journal *PLOS ONE*, Louis-Jean Boë and colleagues said, "Language is a distinguishing characteristic of our species and the course of its evolution is one of the hardest problems in science.

"It has long been generally considered that human speech requires a low larynx, and that the high larynx of non-human primates should preclude their producing the vowel systems universally found in human language.

"Examining the vocalisations through acoustic analyses, tongue anatomy and modelling of acoustic potential, we found that baboons produce sounds sharing the f1/f2 formant (sound frequencies) structure of human vowels."

They said their research confirmed that hominoids like baboons were capable of making contrasting vowel qualities despite their high larynx.

And Boë, of Grenoble Alpes University, France, argued this had significant implications for the beginnings of the languages spoken by people today.

Previously it was thought that the spoken word originated sometime within the last 70,000 to 100,000 years. However, the researchers wrote in the *PLOS ONE* paper that their findings suggested "spoken languages evolved from ancient articulatory skills already present in our last common ancestor with Cercopithecoidea, about 25 million years ago".As part of their work, they listened to some 1,335 spontaneous vocalisations produced by 15 male and female Guinea baboons in different social contexts.

They also studied the anatomy of vocal tracts from two baboons after they had died of natural causes. Humans are able to make vowel sounds because they can precisely control the position of the tongue. The anatomical examinations of the baboons' tongues found they had the same muscles found in humans, suggesting they use a similar technique.

IAN JOHNSTON/THE INDEPENDENT