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Fantastic Farmers

INSIDE STORIES

EDITORIAL

Harvesting Scientifically, Harvesting Smartly

Nakul Parashar

By the time, this issue of *Dream* 2047 reaches you most of our farmers would be getting ready for the harvest. Exciting time of the year, isn't it? Everyone awaits a bumper yield, whether it is a producer or a consumer.

For the past few years, numbers reveal a remarkable rise in our agricultural production. Besides the farmers, it is the effort of our agricultural scientists who deserve a standing ovation for their relentless research anddevelopment. We notice that our farming techniques have improved a great deal when compared with what it was a decade ago. Among the many improvements that we've noticed, we find that Internet-of-Things (IoT) has contributed quite significantly in the stunning growth of this sector.

IoT is a UID-based system of interrelated computers and mechanical machines, objects, animals, and people that can communicate through a network without requiring human-to-human or human-to-computer interaction.IoT has thus provided the farmer with the power of precision farming, smart greenhouses, accurate livestock monitoring, and the use of agricultural drones. Thanks to the vast availability of 4G connectivity. It has provided the ease of access to high-speed internet to the farmers. Additionally, farmers now have easy access to various facets of IT and items like sensors, control systems, robotics, autonomous vehicles, automated hardware, and variable rate technology and much more. This is what is called precision agriculture. It helps the farmer when it comes to raising livestock and growing crops.

CropMetrics, one of the major applications of IoT in agriculture focusses on ultra-modern agronomic solutions, especially in precision irrigation. Variable Rate Irrigation or VRI optimisation is also achieved through IoT. This, in turn, enhances profitability by improving yield and water use efficiency. Soil moisture probes and many such similar scientific instruments through IoT, when combined with various technologies connected through cloud-based ones, haveprovided farmers with the benefits of precision irrigation through a hand-held device like a smartphone.

We've been hearing of drones in the war zones. In agriculture too, IoT has brought agricultural drones into action to help the farmers. In order to assess the crop health, irrigation patterns, crop monitoring, crop spraying, planting, field analyses and much more is aided by the agricultural drones. Real-time data collection and processing is thus done through these drones. Crop health imaging and GIS mapping done through these drones makes the whole process easy to use, saves time and provides accurate analyses. Parameters like plant health indices, plant counting and yield prediction, mapping of drainage and many more are collected easily gathered through multispectral, thermal and visual imagery during the flight of the drone.

Similarly, effective livestock monitoring is possible through IoT, where wireless application assists in location, well-being, and health of the cattle. This way vital information of locating infected animals helps in segregating from the rest to prevent spreading of diseases in the flock. Additionally, it's been observed that locating the position of cattle is made possible through IoT-linked sensors.

The list of advantages in agriculture from IoT applications does not end here. We all know about how greenhouse farming has helped the farmers in enhancing the yield of vegetables, fruits, and other crops. Environmental parameters required for crop growth are controlled through greenhouses. So far these parameters have been manually controlled. Since these are manually governed many disadvantages like loss of production, loss of energy and costs of labour are reported. However, if these greenhouses are designed and fabricated with the help of IoT, automated climate control can be achieved.

There is still a lot that IoT could be applied for, and we could go on counting. Agriculture and what we have just been through is just one of many that are still to be deliberated upon. To end where we began from – our best wishes to our agricultural producers for their bumper harvest and very happy year to come.

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SMASH Theory – A Prologue

K.E. Balagopalan

SMASH theory not only combines several theories, but also relates various branches of sciences. 'Science' is defined as a 'systematised body of knowledge. 'Astronomy' is the science of celestial bodies in the sky. 'astrophysics' is the science of the physical conditions of the celestial bodies whereas; 'cosmology' is the science of cosmos. 'Quantum physics' is the science of 'probabilities' dealing with sub-atomic particles. All these are united together to delve into the mysteries of the universe. In that sense, SMASH is a 'Grand Unified Theory'

While almost all human beings worry about the future, cosmologists worry about the past, for good reasons too, since the reputation of modern cosmology is under threat. Fundamental questions are being raised about the history of the universe, its shape and structure, content and ultimate fate. For these questions, there are no definite answers.

Now, it is time to take deep breath and relax. An interesting new theory about the universe is being presented with a spectacular name, 'SMASH' by an international team of scientists comprising Guillermo Ballesteros, Javier Redondo, Andreas Ringwald and Carlos Tamarit. They claim that with this new theory, five problems of particle physics and cosmology stand solved in one stroke. The SMASH theory is a combination of different theories connected with various aspects in the building up of universe. SMASH is an abbreviation of 'Standard Model-Axion-Seesaw-Higgs' portal inflation model, which make it clear that the new theory has accepted the 'standard model' as it is, and added six new particles, in order to answer the five important, long-standing questions about the universe. This is really a flawless extension of the existing 'Standard model'.

A good theory should describe a wide range of phenomena by a few simple postulates and it should make a definite prediction that can be tested, which is the hard thing about it. As Stephen W. Hawking opined; "It is very difficult to make a mark in experimental physics these days, unless you are already at the top" (*A Brief History of Time*, page 82).

But the SMASH theory is free from this hard job. As the theory makes definite predictions about the precise measurements of the cosmic microwave background radiation (CMBR), it is easily falsifiable and can be tested when eventually the measurements reach in our hand in the near future. If the predictions turn out to be, well and good, the theory is proved. If not, the 'SMASH theory' would get smashed.

The standard model of elementary particles

Six quarks and their anti-quarks constitute the quark family. Though with opposite sign, the properties of anti-quarks are quite similar to those of the concerned quarks. Anti-quarks are particles of antimatter (antimatter of antimatter is again termed as matter). This is only a relative label. Hence, no one would say that there are '12 types of quarks' because of the existence of anti-quarks. (Only the sign flip, which is linked to quantum numbers, is different.) Different varieties of quarks are separated by flavours. There are six flavours - Up and Down, Strange and Charm, and Top and Bottom (Truth and Beauty).

The standard model of fundamental particles also includes the lighter particles called 'leptons', which are also considered to be the building blocks of the universe. There are two main classes of leptons, 'charged' and 'neutral'. Leptons are much lighter

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than hadrons. They do not undergo strong interactions. The best-known lepton is the negatively-charged electron. The other two negatively charged leptons are the 'muon' and 'tau', rather massive than electrons. These are 'point like particles' without an internal structure. Neutral leptons are known as neutrinos.

Unlike quarks, leptons are devoid of colour charge. Electron neutrino, Muon neutrino and Tau neutrino are respectively, the first, second and third generation of neutrino members in the standard model.

Apart from these matter particles (Fermions), Five force-carrying particles (Bosons), photon (carrier of electromagnetic force), gluon (carrier of strong nuclear force), and four bosons, W^+, W^-, Z^0 and 'Higgs boson' constitute the Standard Model of elementary particles.

The discovery of the 'Higgs boson' at CERN (European Organisation for Nuclear Research) in July 2012 proved that these particles had no mass of their own at the very beginning of the universe. Within fraction of a second, when the universe had cooled down to a temperature of 10^{28} Kelvin, with an inflationary expansion, an invisible field called the 'Higgs field' was formed in association with these particles. This field gave mass to all matter particles passing through it.

This model was not enough to answer all the important questions about the universe although most of the predictions hold well to date. 'SMASH' theory is expected to correct all the flaws.

The standard model was considered as the "Bible of quantum physics' and every time there was a new arrival, it had to be weighed with the model to confirm whether it fitted in or stood out. The model did have flaws. It was incomplete and unclear when describing the universe from big-bang to the present era. To find experimental proof for certain particles, a lot of time as well as huge sums of money and man-power had to be utilised.

The flaws

As the relativity theory and quantum theory could not go hand in hand, gravity, which rules the universe at macro scale, is left undescribed.

Dark energy and cold dark matter forming a major part (approximately 95%) of the universe could not be accounted for.

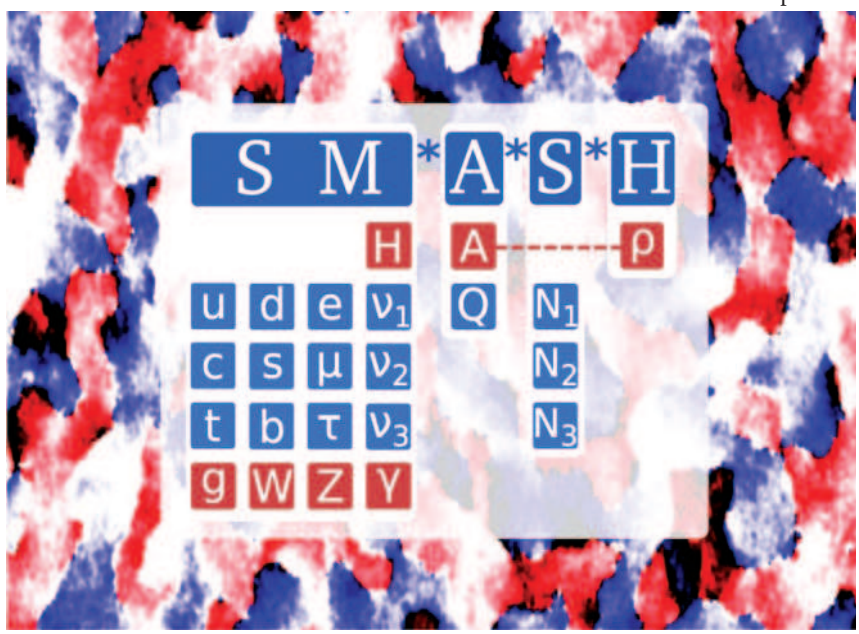
The model predicts equal number of particles and anti-particles. If so, due to mutual annihilation, only a sea of light would have been the result. But experience is quite different.

The standard model predicts 'zero' mass for neutrinos. But it has been proved by the Nobel Laureates of 1915 that these particles have a tiny mass.

The standard model should have contained a term that breaks CP symmetry (in relation to matter-antimatter) in the strong interaction sector. But there is no experimental proof hitherto available for CP violation.

Cosmic microwave background radiation (CMBR)

The cosmic microwave background radiation is the electromagnetic radiation left over from the early stages of the universe. After about 3,00,000 years, hydrogen atoms were formed from the dense soup of 'quark-gluon plasma' as well as from the stable nuclei with protons and neutrons. As the atoms could not absorb the radiation, and as neutral hydrogen is transparent to light, the matter decoupled from radiation thereby releasing the light. This 'afterglow' is also known as 'relic radiation', which was strong in the microwave region of the radio spectrum. The heavy flow of intense light, ranging from radio waves to high-energy gamma rays, was held back by gravitational pull stretching them to microwave wavelengths like a stretched spring.



The questions that remain unanswered

Limitation of the standard model has left five disturbing questions unanswered.

1. If the universe had started with equal number of matter and antimatter particles, why is there more matter than antimatter in the universe?
2. What is dark matter?
3. How did an inflationary growth expand the universe within seconds?
4. How to explain the CP problem faced by the strong nuclear force, causing asymmetry in strong force?
5. Why are neutrinos so light?

The 'SMASH' theory

The SMASH theory is a combination of various theoretical approaches to get a simple but uniform model. Accepting standard model as it is, the SMASH theory added six new particles to the standard model. The new particles are: three heavy, right-handed neutrinos, N_1, N_2, and N_3, (the neutrinos presented by standard model are left-handed and light), an additional triplet quark, a heavy Rho particle (ρ) and an axion - the dark matter particle.

With the help of see-saw theory, 'SMASH' explains the mass of neutrinos, balancing the three known, very light, left-handed neutrinos with a much heavier counterpart. The right-handed and heavy neutrinos are N_1, N_2, and N_3. The unbalanced decay of these heavy neutrinos as matter rather than anti-matter is the root cause for the domination of particles over anti-particles.

The colour triplet fermion

A colour triplet fermion is simply a fermion that behaves like a quark with respect to the strong force. It behaves like a quark with same electrical and colour charge. It is least affected by electro-weak force in coupling into right-handedness or left-handedness and this shows a slight difference from the quarks. This particle is selected to team with other particles in the SMASH theory.

The rho particle

Considered to be a meson, the rho particle carries the nuclear force within the atomic nucleus in binding proton and neutron together. The predicted mass is between 50 and 200 millionth of an electron volt.

It is composed of one quark and an anti-quark (one 'up' quark and one 'down anti-quark' in its charged state). This particle together with Higgs Boson gives mass to the right-handed neutrinos and drives the cosmic inflation. The inflationary growth during the first split seconds of the Big-Bang is not only explained but also made testable.

Standard model of fundamental particles

Massive	Hadrons	Quarks	Fermions (Matter particles)			Bosons (Force carrying particles)		
			Up	Strange	Top (Truth)	Strong nuclear force	Electro-magnetic force	
			Down	Charmed	Bottom (Beauty)	Gluon	Photon	
Less massive	Leptons		First generation	Second generation	Third generation	Gauge Bosons		Scalar Bosons
			Electron	Muon	Tau	W^+ Boson	Z^0 Boson	Higgs Boson
			Electron neutrino	Muon neutrino	Tau neutrino	W^- Boson	(Electro-weak force)	

'CP' preserving? There was only one simple solution. At least one of the quarks should be massless. But in effect, none of the quarks is massless.

An elegant solution was postulated by Roberto Peccei and Helen Quinn in 1977. Introducing a new particle, which did away with the CP problem, the scientific community was relieved. The new introduction accomplished a new global symmetry that becomes spontaneously broken and relaxed the CP violation to 'zero'. This hypothesised new particle is the 'axion'.

This very axion becomes a 'dark matter' particle with its tiny mass about 10^{-11} times of electron mass. One of the merits of this hypothesis is that the axion can be detected on Earth, converting them to photons of X-rays with a strong magnetic field. ADMX is a highly magnetised resonant cavity which uses a strong magnetic field to convert dark matter axions to detectable to microwave photons.

If axions entered it, then they would interact with the intense magnetism and disintegrate into photons. Once they disintegrate into photons, then they can never pass back through the casing of the cavity. Instead, they would remain inside, bouncing off the walls, emitting a faint microwave signal, which ADMX should be able to detect.

SMASH Theory

Massive	Hadrons	Quarks	Fermions (Matter particles)			Bosons (Force-carrying particles)		Axion (Cold dark matter particle)		Rho particle (ρ)
			Up	Strange	Top (Truth)	Strong nuclear force	Electro- magnetic force			
			Down	Charmed	Bottom (Beauty)	Gluon	Photon	Triplet Quark	Right-handed heavy Neutrinos	N_1
Less massive	Leptons		First generation	Second generation	Third generation	Gauge Bosons	Scalar Bosons			N_2
			Electron	Muon	Tau	W^+ Boson	Z^0 oson	Higgs Boson		
			Electron neutrino	Muon neutrino	Tau neutrino	W^- Boson	(Electroweak force)			N_3

The axions

The standard model, in principle, permits violation of 'CP'. This means, the combined symmetries of charge conjugation and parity transformation are very slightly affected by the weak force. This was treated as a natural flaw of the Standard Model. Still the question remained, why should the quantum chromodynamics find itself as

The axion has no electric charge. It has only a tiny mass ranging from 10^{-6} to 1 ev/c^2. It interacts only very slightly with strong and weak forces and so also with ordinary matter. In magnetic fields, the axions would swing to and from 'photons' as explained above. The axion itself is its super

Continued on page 29

Fantastic Farmers

Chandrayee G. Bhattacharyya

As humans we fancied to think of ourselves as the supreme, divine and incomparable ones on Earth. For example, we thought that our domestication of plants and animals is the one and the only kind of innovation. But there are clear parallels from the world of non-human humble animals too. These modest farming-creatures can teach us more about the management of agricultural pathogens. After all, they have been farming for millions of years.

Farming or agriculture has been a turning point in humankind's transformation from the nomadic life of a hunter-gatherer to a plant domesticator and food grower that made settled life possible. Agriculture brought about important changes in the life style of humans; they gave up their nomadic life and settled down at one place in selected areas. They put forward the first step towards development. It is estimated that the practice of agriculture started around 12,000 years ago. It guaranteed food supply for the world's growing population. Over the years, agriculture has advanced in leaps and bounds, increasing global food production many folds. But, interestingly, humans are not the only ones to practise farming to assure a settled life and guaranteed food supply. There are others in the world of creatures, notably the black-ants and leafcutter ants which do the same. There exists ample scientific evidence that these humble tiny arthropods – several species of ants and termites – have been practising farming for guaranteed food supply for millions of years.

Considering the fossil evidence scientists presume that ants and termites evolved in the Late Permian period, i.e., approximately 290 to 245 million years ago. These prehistoric farmers, the diminutive arthropods, definitely deserve kudos for inventing the practice of farming (and not us!).

There are ants and many ant-like creatures that evolved their fungus-growing ability in the course of evolution over millions of years. The most widely acclaimed ones are the famous "leafcutter ants" which grow fungi in their nests. Termites are no exception. Inside the termite-mounds there are honeycomb-like structures within which termites grow fungus. Amazingly they are not just superb architects, they are marvellous farmers too.

Black ants (*Lasius niger*)

Some species of ants such as black ants do the farming of aphids (Fig.1). The ants protect these aphids on plants. They eat the honeydew (a sugar-rich sticky liquid) secreted by aphids. Biologically this is a wonderful mutualistic relationship. What is most interesting is that these 'dairying' ants 'milk' the aphids by stroking them with their antennae!

Recent research shows that chemicals

Black ants farming aphids

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on the ants' feet tranquillise and thereby subdue colonies of aphids. They keep these tamed creatures close by as a ready source of food. The study throws new light on the complex relationship between ants and the colonies of aphids whose sugary secretions are the ants' food. Chemicals produced by the glands of ants obstruct the growth of aphid wings. The ants bite the wings off the aphids in order to stop them from getting away and depriving the ants of one of their staple foods, honeydew. Recent studies show that the ants use chemicals to mark out their territory. Interestingly these chemicals also play a key role in manipulating the aphid colony and keeping those creatures nearby.

Researchers believe that ants use their tranquillising chemicals in their footprints to maintain a populous 'farm' of aphids close to their own colony, so that it would provide honeydew on tap. These ant herders are nomadic pastoralists as well, with aphids playing the role of their cattle and sheep. Researchers have documented black-ants attacking and fighting off ladybirds and other predators that eat aphids.

Leafcutter ants (*Atta* species)

Humans have been farming crops for thousands of years, but we are definitely pretty new arrivals to the scenario of agricultural practice. The famous leafcutter ants (Fig.2) have been doing the same thing for millions of years. These species of tropical, fungus-growing ants are all endemic to South and Central America, Mexico, and parts of the southern United States. If you are a fan of wildlife documentaries, probably you would have seen these industrious leafcutters on TV channels before. They march in vividly coloured columns with leaf pieces held aloft in their jaws very much like flags. The sliced fragments of leaves are carried back to the nest and fed to a fungus they grow, which the ants eat. Neither the ant nor the fungus can survive without each other. This weird partnership has ensured the leafcutter-ants' success. Around the world there are more than forty different species, forming the largest group of ants.

Leafcutter ants farming fungi

Leafcutter ants are often compared to 'farmers'. Unbelievable though, it's true that they apply fertilisers to their crops (i.e., fungus), in the form of bacteria that provide nitrogen to the fungal gardens and they also use pesticides in the form of antibiotic-releasing bacteria that protect their fungi-crop from parasites and/or competitors.

Let's take a look at a few other similar examples.

The ambrosia beetles (*Xyleborus* and other genera)

According to researchers at the University of Florida in Gainesville, USA, ambrosia beetles are largely ignored compared to ants, but they are much more ubiquitous. Ambrosia beetles are beetles of weevil subfamilies, which live in nutritional symbiosis with ambrosia fungi. These fungi-growing beetles (Fig.3) are found everywhere from the tropics to temperate climates. The fungi depend on the beetles for their entry into the interior tissues of the trees. The bark presents a formidable barrier. These beetles have evolved specialised pockets on their bodies to carry the sticky spores of the fungi when they move on after thoroughly exploring their host tree. The fungi species extracts nutrients from the tree tissue that the beetle cannot do. Thereafter the beetle larvae gobble up the nutritious fungi.

Ambrosia beetle

The damselfish (*Chromis chromis, Pomacentrus sp* and other species)

The damselfish (Fig.4) is one of the most abundant in the coral reefs across the world – from Indonesia to the Caribbean islands. They can grow up to 36 cm long.

Damsel fishes

While most are marine, a few species inhabit the lower stretches of rivers in fresh water. Damselfish usually have bright colours. Some species of damselfish feed mainly on plant matter or tiny crustaceans suspended in the water; others are omnivorous. Most damselfishes live along reefs, but certain species, the anemone fishes, for example, are noted for living among the stinging tentacles of sea anemones. They live within the coral-reef gardens and cultivate their desired algae species. These fishes selectively weed the algal gardens on which they feed in order to encourage the growth of their preferred algal species and suppress the growth of less palatable algae. Researchers at James Cook University in Queensland, Australia studied damselfish on the Great Barrier Reef and recorded the above stated interesting observations. Damselfishes have also been documented protecting their algal gardens from the threat of thieves and invaders.

Marsh snails (*Littoraria irrorata*)

Another interesting invertebrate member has recently acquired a place in this fold of farming-fraternity. They are the marsh snails (*Littoraria irrorata*), which are abundant in salt marshes (Fig.5). Primarily they live on fungi that grow on dead plant materials. Plant scientists have recently

Marsh snails

observed these unique invertebrates grazing on live cordgrass (*Spartina alterniflora*) – a genus of plants in the grass family frequently found in coastal salt marshes. Ecologists have recorded that the snails do not actually eat the live plant material but devour the fungi growing on cordgrass leaves. These snails use their radula, a tongue-like organ, to cut wounds into leaf surfaces, which enable the desired fungi to invade and thrive in the wounds on the leaf-surface. These snails were observed to actively promote the fungi's invasion of the wounds by depositing their faecal pellets, which are full of both nitrogen and fungal spores/hyphae, on the wounded surface of the leaves. These farming-snails grow and their juveniles survive with access to the fungi-rich leaves. Researchers have found that, compared to uninjured leaves, wounded leaves carried fifteen times more fungi by weight. Marsh snails are incredible fungus growers indeed!

As humans we fancied to think of ourselves as the supreme, divine and incomparable ones on Earth. For example, we thought that our domestication of plants and animals is the one and the only kind of innovation. But there are clear parallels from the world of non-human humble animals too. These modest farming-creatures can teach us more about the management of agricultural pathogens. After all, they have been farming for millions of years, and maybe they have figured out some skilful acts, which maybe incomprehensive for us today, but led them to their remarkable agricultural success.

If you are a nature enthusiast chances are that you may come across black-ants moving very close and fondling the woolly tiny aphids in the wilderness. Sitting on your cosy couch while enjoying TV shows, as you look at the spectacular aerial views of terraced-paddy-fields on highlands, salute the astute farmers-of-the-past for their indomitable spirits, their industrious efforts and superb foresight. But at the same time please don't forget to appreciate the agricultural skills of fungus-growing termites and ants. Look at their ingenious skills of creating marvellous three-dimensional designs, on the walls of which the fungi grow (Fig.6); indeed they are the world's foremost farmers. Thus, we must not forget to celebrate the achievements of these humble creatures. ■

Termites farming fungi

SMASH Theory – A Prologue *(Continued from page 32)*

partner. Here, it sorts out the problem of non-breaking symmetry by the strong force, as predicted by the Standard Model. The strong force internally continues its service of bringing the nuclei of atoms together.

The see-saw theory

This is a generic model used to understand the relative sizes of observed neutrino masses in the grand unification of particles. Compared to quarks and charged leptons, neutrinos have only very low masses. While all other particles get mass by passing through the 'Higgs field', why is the electron neutrino in Standard Model is 10^5 times lighter than the electron and the up and down quarks? If the coupling with Higgs field be zero, the mass would be zero for neutrinos. On the other hand, if there is coupling, the particles could acquire mass in the 'symmetry breaking scale'. It is learned that the quantum superposition of Higgs field can result in light neutrinos (already observed) and in very heavy neutrinos as well (yet to be observed). Such neutrinos would decay as 'bottom quarks' and 'leptons'.

The smallness of the neutrino mass results from the exchange of heavy messenger particles such as right-handed iso-singlet neutrinos and/or iso scalar triplet bosons as per the see-saw mechanism.

The see-saw extension of the Standard Model may have deep implications for new physics ranging from neutrino physics to other aspects of particle physics and cosmology.

SMASH theory not only combines several theories, but also relates various branches of sciences. 'Science' is defined as a 'systematised body of knowledge. Before 'Science' (the study of nature through close observation), it was 'Philosophy' (the study of nature through deep thought). 'Astronomy' is the science of celestial bodies in the sky. 'astrophysics' is the science of the physical conditions of the celestial bodies whereas; 'cosmology' is the science of cosmos. 'Quantum physics' is the science of 'probabilities' dealing with sub-atomic particles. All these are united together to delve into the mysteries of the universe. In that sense, SMASH is a 'Grand Unified Theory'. ■

Antioxidant Phytochemicals are Beneficial for Health



Dhan Prakash, Charu Gupta and Girish Sharma

When production of reactive oxygen species exceeds the body's antioxidant defence system, it results in oxidative stress, which arises mainly from increase in oxidant generation, decrease in antioxidant protection and failure in repair of oxidative damage. Exposure to pathogens, inappropriate lifestyle, excessive exercise and by-products of normal metabolism are also contributing factors to oxidative stress.

Introduction

Reactive oxygen species are chemically reactive chemical species containing oxygen. Examples include peroxides, superoxide, and hydroxyl radical. They are also produced on exposure to sunlight, X-rays, ozone, tobacco smoke, automobile exhaust, environmental pollutants and by several physiological processes. Presence of unpaired electron in their outer orbit makes them highly reactive and they can damage nucleic acids, proteins, lipids and carbohydrates and consequently affect immune functions, causing degenerative diseases. When production of reactive oxygen species exceeds the body's antioxidant defence system, it results in oxidative stress, which arises mainly from increase in oxidant generation, decrease in antioxidant protection and failure in repair of oxidative damage. Exposure to pathogens, inappropriate lifestyle, excessive exercise and by-products of normal metabolism are also contributing factors to oxidative stress. It deregulates the cellular functions which affects the immunity and leads to degenerative diseases such as cancer, diabetes, ulcers, inflammation and cardiovascular diseases. Antioxidants are known to defuse reactive oxygen species leading to reduce the risk of oxidative stress and associated disorders.

Phytochemicals with antioxidant capacity naturally present in food, fruits and vegetables are of great interest due to their beneficial effects on human health as they offer protection against oxidative deterioration. Epidemiological and animal studies suggest that the regular consumption of fruits, vegetables and whole grains, reduces the risk of various chronic diseases, like cancer, diabetes, inflammation, neurodegenerative disorders and ageing associated with oxidative stress. Compounds like polyphenols, carotenoids, tocopherols, ascorbates and lipoic acids generally present in various foods are strong natural antioxidants with free radical scavenging activity. Endogenous antioxidant enzymes like superoxide dismutase (SOD), catalase, glutathione peroxidase, glutathione reductase, minerals like Se, Mn, Cu, Zn, vitamins A, C and E, carotenoids, limonoids and polyphenols exert synergistic actions in scavenging free radicals.

These phytochemicals are important for scavenging reactive oxygen species and consequently prevent mutagenic changes and associated disorders. Main sources of biologically active polyphenols are berries, red wine, onions, apples, red grapes, citrus, green tea, licorice, rosemary, thyme, fruits and vegetables. Isoflavones like daidzein and genistein found abundantly in legumes such as lentils, chickpeas and soybeans, offer protection against tumour growth, and breast and uterus cancer. The natural

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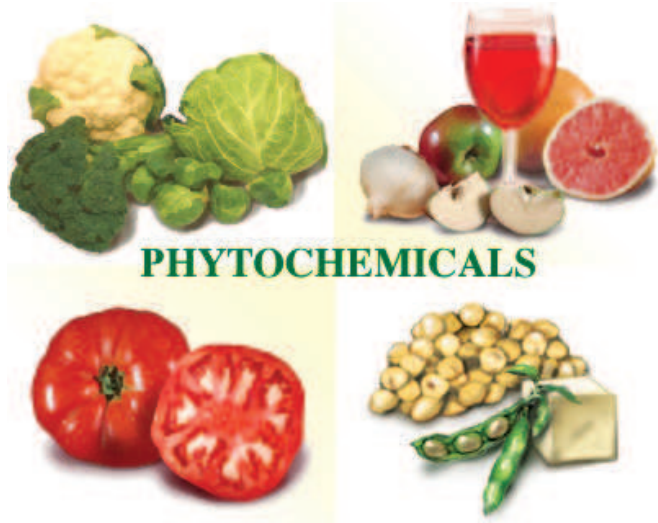
antioxidants like carotenoids, tocopherols, ascorbates, lipoic acids and polyphenols offer protection against the deleterious action of free radicals that play an important role in human health. Synthetic antioxidants such as butylated hydroxy anisole (BHA) and butylated hydroxy toluene (BHT) are useful in food and pharmaceutical industries. Some examples of major phytochemicals with antioxidant activity are discussed below.

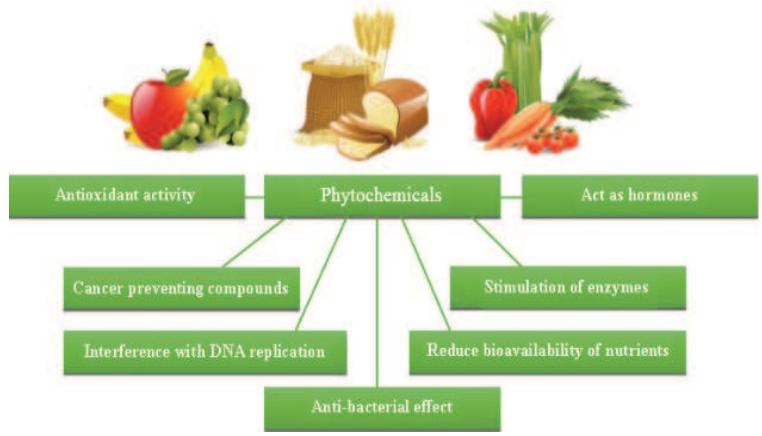


Polyphenols

Polyphenols are flavonoids and phenolic acids and account for about 60% and 30% of total phenols, respectively. Ellagic acid is the most potent natural chemo-preventive agent, which prevents oxidative damage of connective tissue and repairs damaged proteins present in the walls of blood vessels. Flavonoids possess ideal structure for free radicals scavenging activity and have been found to be more effective antioxidants *in vitro* than tocopherols and ascorbic acid. More than 4,000 flavonoids have been identified in plants, which are responsible for the colour of vegetables, fruits, grains, seeds, leaves, flowers, bark and products derived from them. Luteolin, kaempferol, quercetin, rutin, myricetin and vitamin C are powerful antioxidants that inhibit the oxidation of low-density lipoprotein (LDL), a major factor in the promotion of atherosclerosis, which is the plaque build-up in arteries that can lead to heart attack or stroke. Isoflavones like daidzein and genistein found abundantly in legumes such as soybeans, chickpeas and lentils, have nutraceutical properties against tumour growth and cancer.

Biological effects of polyphenols are of great interest since evidences were found that they offer protection against gastro-duodenal pathogenesis, premature aging, inflammation, metabolic dysfunction, cancer, neuro-degenerative and cardiovascular diseases. Some studies have shown that the consumption of beverages and foods rich in polyphenols results in reduced risk of cancer and cardiovascular diseases. They can also enhance the efficacy of vitamin C, thereby resulting to reduce further the risk of above-mentioned diseases and effective in controlling hypertension.

Epidemiological studies provide convincing evidence that diet rich in antioxidants is associated with a lower incidence of cancer, cardiovascular and degenerative diseases. Cereals, legumes (barley, corn, nuts, oats, rice, sorghum, wheat, beans, and pulses), oilseeds rape seed, canola, flax seed and olive seeds), fruits, vegetables and beverages (fruit juices, tea, coffee, cocoa, beer and wine) are the main sources of dietary polyphenols. Fruits like apple, grape, pear, cherry, various berries and tea are good natural sources of polyphenols. The main source of isoflavonoid is soybean which contains genistein and daidzein and has received considerable attention due to their suggested role in prevention of cancer and osteoporosis. People who consume traditional diets rich in soy and tea rarely experience breast, uterus and prostate cancer.



Carotenoids

There are more than 700 naturally occurring carotenoids that act as biological antioxidants and protect cells and tissues from the damaging effects of free radicals. Carrots, tomatoes, parsley, orange and green leafy vegetables like amaranth, chenopods, mustard, fenugreek, spinach, cabbage, pumpkin and papaya are the rich sources of carotenoids. Among the carotenes, only alpha, beta and epsilon carotenes possess vitamin A activity and out of them beta-carotene is the most active. Natural beta-carotene is the precursor of vitamin-A and has preventive action against eye diseases and cancer. Carotenes enhance immune response and protect skin cells against UV radiations. They help lower the risk of cardiovascular diseases, age related vision disorders, asthma and reduce inflammation. Lycopene gives red colour to tomatoes and is particularly effective in protecting from harmful effect of free radicals. Along with carotene and lutein, it provides protection against lung, breast, uterus and prostate cancers. Green leafy vegetables and corn are best source of xanthophylls like lutein and zeaxanthin that are believed to function as protective antioxidants for the retinal part of human eye. Astaxanthin, a xanthophyll found in sea foods is also a potent antioxidant. Limonoids are the biologically active phytochemicals present in citrus which act as antioxidant and protect lung tissues from reactive oxygen species and have significant ability to inhibit proliferation of human breast cancer. In addition, dietary intake of carotenoids reduces the risk for certain types of cancer, cardiovascular and other chronic diseases.

Vitamin-E (Tocopherols)

The first dietary role discovered for tocopherol was as an essential nutrient for normal development of an animal foetus. The alpha-tocopherol is the most abundant form with high vitamin E activity and ability

to protect from free radicals than other forms of tocopherols. Gamma-tocopherols can reduce the concentration of nitrogen dioxide most effectively, which is involved in carcinogenesis, arthritis and neurologic diseases. Tocopherols are associated with the reduced risk of cancer, Alzheimer's and cardiovascular diseases, cholesterol lowering ability and inhibited low-density lipoprotein (LDL) oxidation. The main rationale for the use of vitamin E to prevent atherosclerosis and coronary heart disease is based on the idea that alpha-tocopherol prevents oxidation of LDL cholesterol. Almonds, spinach, sweet potato, avocado, wheat germ, sunflower oil, palm oil, butternut squash and olive oil are good sources of vitamin-E.

Vitamin C (Ascorbic acid)

Ascorbic acid found in fruits and vegetables is a leading natural antioxidant that can reduce the risk of free radicals on health and has anti-carcinogenic effects. It may be related to the prevention of some forms of cancer and heart diseases. Ascorbic acid and tocopherol supplementation can substantially reduce oxidative damage and associated diseases. Their effects are greater in non-smokers than in smokers. Smoking induces oxidative stress from numerous free radicals in the gaseous phase and the radicals formed from ascorbic acid act as pro-oxidants in smokers. (Pro-oxidants are chemicals that induce oxidative stress.) Reactive oxygen species contain an extra electron and thus are highly reactive and damaging to humans and plants at the molecular level. This is due to their interaction with nucleic acids, proteins and lipids. Oranges, kiwi, peppers, kale, sprouts, broccoli, strawberries, grape fruits, guava and citrus fruits are good sources of vitamin-C.

Lipoic acid

Some sulphur-containing compounds like glutathione (GSH), lipoic acid (1, 2- dithilane-3-pentanoic acid) and dihydro-lipoic acid present in meat show antioxidant activities. They prevent oxidative damage of proteins; regenerate GSH in liver, kidney and lung tissues. There is evidence to show that they reduce diabetic-related complication and thus play an important role in reduction of blood glucose concentration. Lipoic acid improves mitochondrial membrane potential, age-related memory loss and brain ailments, including Alzheimer's and Parkinson´s disease. Racemic lipoic acid has been widely used in the treatment of cirrhosis, mushroom poisoning and in case of metal intoxication. Due to its essential role in health, alpha-lipoic acid may very well join the ranks of vitamins C and E as part of first-line of defence against free radicals. Like other antioxidants, alpha lipoic acid can help slow down cellular damage that is one of the root causes of diseases like cancer, heart disease and diabetes. Lipoic acid is present in almost all foods in very low amounts, but slightly more in spinach, broccoli, and yeast extract.

Conclusions

Overproduction of reactive oxygen species results in oxidative stress, which is a deleterious process that can be an important mediator of damage to cell structures and consequently resulting in various diseases. Phytochemicals with antioxidant activity such as carotenoids, flavonoids, polyphenols, vitamin C and E present in fruits, vegetables, cereals and legumes are important in controlling oxidative stress and offer protection against cancer, diabetes, ulcers, inflammation, neurodegenerative and cardiovascular diseases. Thus, the future of antioxidants holds a great promise to ensure a better disease-free lifestyle for humankind by scavenging reactive oxygen species and consequently preventing mutagenic changes and associated disorders. ■

Aloe vera: The "sanjeevani" plant

C.P. Reghunadhan Nair

Aloe vera has been used for medicinal purposes for health, beauty, and skin care in different parts of the world for several centuries. Aloe vera contains about 75 potentially active constituents including vitamins, enzymes, minerals, sugars, lignin, saponinsand amino acids that can act as remedy for many ailments qualifying its nickname, panacea.

Introduction

Aloe vera is a natural product that is now a day frequently used in the field of cosmetology. Though there are various indications for its use, controlled trials are needed to determine its real efficacy. The aloe vera plant, its properties, mechanism of action and clinical uses are briefly reviewed in this article.

Keywords: *Aloe vera*, *health and beauty*, *skin*

The *Aloe vera* plant, which the Egyptians called the 'plant of immortality', is a green-coloured stem less succulent plant that stores water as sap in its leaves making them fleshy and thick. The name *Aloe vera* derives from the Arabic word "*Alloeh*" meaning "shining bitter substance," while "*vera*" in Latin means "true." 2000 years ago, Greek scientists regarded *Aloe vera* as the universal panacea. Today, the plant is used for various medicinal purposes.

Aloe vera (botanical name *Aloe barbadensis* miller), belongs to Asphodelaceae (Liliaceae) family and grows mainly in the dry regions of Asia, Europe, America and Africa. In India, it is found in Rajasthan, Andhra Pradesh, Gujarat, Maharashtra, Tamil Nadu and some parts of Kerala. The plant has triangular, fleshy leaves with serrated edges, yellow tubular flowers and fruits that contain numerous seeds. Each leaf is composed of three layers: An inner clear gel that contains 99% water and rest is made of glucomannans (water-soluble polysaccharides), amino acids, lipids, sterols and vitamins. The middle layer of latex is bitter yellow sap and contains anthraquinones and glycosides. The outer thick layer of cells synthesises carbohydrates and proteins.

What is so special about *Aloe vera*?

Aloe vera has been used for medicinal purposes for health, beauty, and skin care in different parts of the world for several centuries. There is a medical record regarding its use in treatment of dermatitis that goes back to AD 1655. Fig. 1 shows an advertisement for Aloe vera products in very earlier days.

The question, what makes *Aloe vera* so special, is answered by the fact that unlike many other medicinal plants, this one contains about 75 potentially active constituents including vitamins, enzymes, minerals, sugars, lignin, saponins and amino acids that can act as remedy for many ailments qualifying its nickname, panacea. We shall examine some of these aspects.

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Benefits for Health

1. Prevent Signs of Aging
2. Moisturises Skin
3. Reduces Acne and Helps Lighten Blemishes
4. Helps with sunburns and Reduces Tan
5. Heals External wounds and Insect Bites
6. Reduces Stretch Marks
7. Promotes Hair Growth
8. Reduces Dandruff
9. Maintains pH Balance of the Scalp
10. Conditions Hair

Benefits for Health

11. Reduces Inflammation
12. Eases Heartburn and Acid Reflux
13. Reduces Cholesterol And Regulates Blood Sugar
14. Maintains Oral Health
15. Builds immunity

Fig.1. An early advertisement for typical Aloe vera products

Panacea for skin care

The vast majority of applications of *Aloe vera* has been in making different natural or semi synthetic smoothening creams for facial application by making use of its reducing property. A large number of *Aloe vera*-based food supplements emerge on a daily basis. The proliferation of such products and the companies that produce them speak for themselves and give a clear indication of the direction in which *Aloe vera moves*. The plant has been proven time and again as an effective anti-dermatitis medicine.

Constituents of Aloe vera

Vitamins

Aloe vera contains vitamins A, C and E, which are known antioxidants. It also contains vitamin B_{12}, folic acid and choline (Fig.2).Vitamin B12, also known as cyanocobalamin, is a water-soluble vitamin that has a key role in the normal functioning of the brain and nervous system via the synthesis of myelin, and the formation of red blood cells. Folic acid is used to treat anaemia and as a supplement for women during pregnancy to prevent neural tube defects (birth defects of the brain, spine, or spinal cord). Long term supplementation reduces the risk of stroke and cardiovascular disease. Choline is a macronutrient that is important for liver function, normal brain development and nerve function, muscle movement, supporting energy levels and maintaining a healthy metabolism.

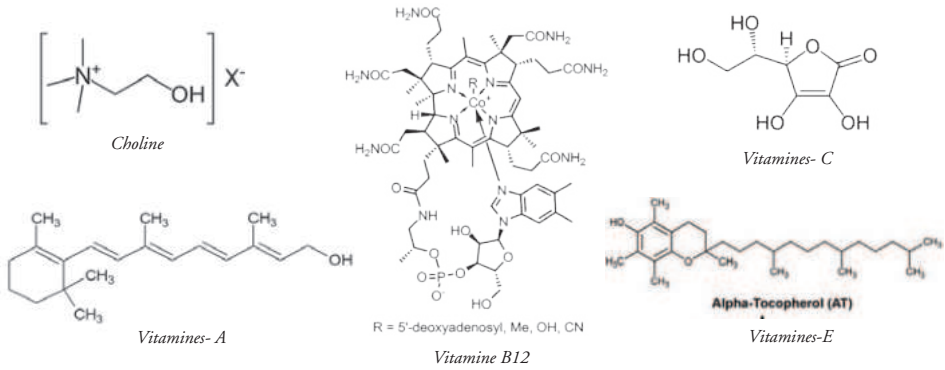


Fig 2 : Chemical Structures : (i) Choline (ii) Vitamine B12, (iii) Vitamines- C, A and E

Minerals

Aloe vera provides the minerals, calcium, chromium, copper, selenium, magnesium, manganese, potassium, sodium and zinc. They are essential for the proper functioning of various enzyme systems in different metabolic pathways, and a few serve as antioxidants.

Enzymes

The plant contains eight enzymes, namely alkaline phosphatase, amylase, bradykinase, carboxypeptidase, catalase, cellulase, lipase, and peroxidase. Among these, bradykinase helps reduce excessive inflammation when applied to the skin topically, while others help in the breakdown of sugars and fats.

Sugars

Aloe vera is rich in monosaccharides (glucose and fructose) and polysaccharides (glucomannans, polymannose). These are derived from the mucilage layer of the plant (togetherknown as mucopolysaccharides). Additionally the gel contains Alprogen, a glycoprotein with anti-allergic properties,and an anti-inflammatory compound,C-glucosylchromone.

Anthraquinones

Aloe vera contains 12 anthraquinones. Among these, emodin and aloin (Fig.3) are known for their analgesic, antibacterial and antiviral activities.

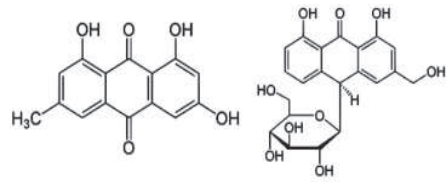


Fig.3. Chemical structures of Emodin and Aloin

Steroids

Aloe vera contains four plant steroids, namely cholesterol, campesterol, β-sisosterol and lupeo. All these have anti-inflammatory action and lupeolin particular, possesses antiseptic and analgesic properties also.

Hormones

Auxins and gibberellins (Fig.4) present in *Aloe vera* help in wound healing and have anti-inflammatory action.

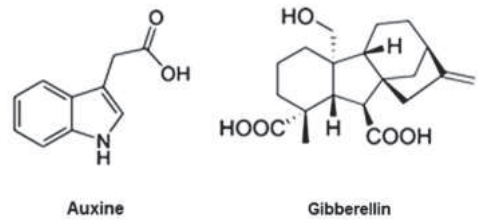


Fig. 4. Chemical structures of a typical Auxine and Gibberellin

Amino acids and saponins

Aloe vera is the only source of 30 amino acids that humans need. It also contains salicylic acid that possesses analgesic (pain reliever), anti-inflammatory and

Continued on page 19

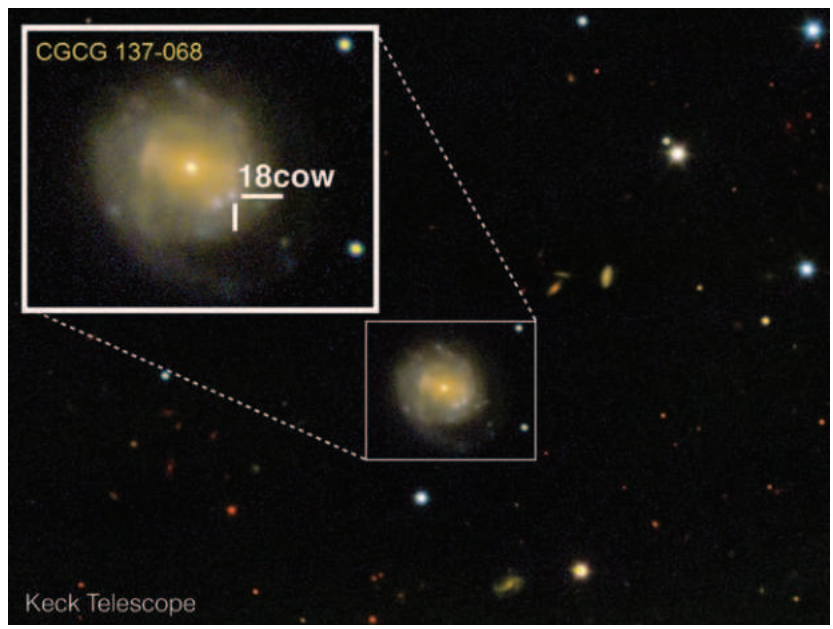
Recent Developments in Science and Technology

Biman Basu

Astronomers capture birth of a black hole for the first time

Black holes are among the strangest and most fascinating objects found in outer space. First predicted by Albert Einstein in 1916 with his general theory of relativity, black holes are objects of extreme density, with such strong gravitational attraction that even light cannot escape from their grasp if it comes near enough. The term "black hole" was coined in 1967 by American astronomer John Wheeler, and the first one was discovered in 1971. Astronomers estimate that our galaxy contains some 100 billion stars and 100 million black holes.

Most black holes form when supermassive stars collapse into a dense gravitational mass that absorbs all light. But till recently, astronomers had never observed the actual 'birth' of a black hole; now they think they have observed one. The inference comes from the detailed analysis of a spectacularly bright flash observed in the Hercules constellation 200, million light years away, with the help of W. M. Keck Observatory on Mauna Kea, Hawaii and the University of Hawaii Institute for Astronomy's ATLAS twin telescopes on 17 June last year. Dubbed AT2018cow or "The Cow", the object quickly flared up and then vanished almost as quickly. According to astronomers, the flash was unnaturally bright - 10 to 100 times brighter than a typical supernova. It also flared up and disappeared much faster than other known star explosions.



A look at 'The Cow' (approximately 80 days after explosion) from the W.M. Keck Observatory in Mauna Kea, Hawaii. The Cow is nestled in the CGCG 137-068 galaxy, 200 million light years from Earth. (Credit: Raffaella Margutti/Northwestern University)

After it was first spotted, The Cow captured immediate international attention and left astronomers scratching their heads because of the unusual nature of the event. Astronomers have traditionally studied stellar deaths in the optical wavelength, which uses telescopes to capture visible light. But an international team led by Raffaella Margutti of Northwestern University, USA, used a more comprehensive approach. Her team observed the object with X-rays, hard X-rays (which are 10 times more powerful than normal X-rays), radio waves and gamma rays. After ATLAS spotted the object, Margutti's team quickly obtained follow-up observations of The Cow with NASA's Nuclear Spectroscopic Telescope Array (NuSTAR) and INTEGRAL hard X-ray laboratories, soft X-rays at XMM-Newton and radio antennae at the Very Large Array were turned toward The Cow. The team also obtained optical images from the MMT Observatory in Arizona, as well as the Southern Astrophysical Research (SOAR) Telescope in Chile. This enabled them to continue studying the anomaly long after its initial visible brightness faded. After combining the images in different wavelengths, the astronomers now speculate that the telescopes captured the exact moment a star collapsed to form a compact object, such as a black hole or neutron star.

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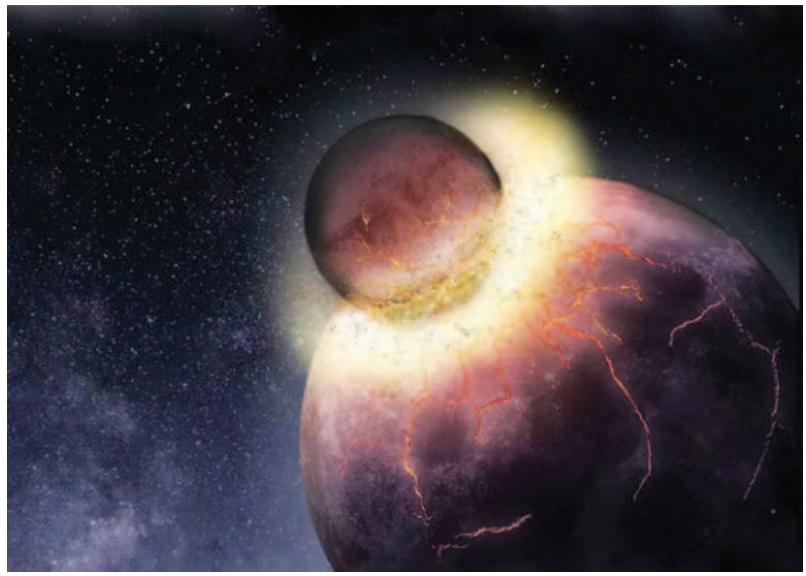
"Based on its X-ray and UV emission, 'The Cow' may appear to have been caused by a black hole devouring a white dwarf. But further observations of other wavelengths across the spectrum led to our interpretation that 'The Cow' is actually the formation of an accreting black hole or neutron star," says Margutti, who is assistant professor of physics and astronomy at Northwestern University. It is believed this rare event will help astronomers better understand the physics at play within the first moments of the creation of a black hole or neutron star. The findings were presented by Margutti at the 233rd meeting of the American Astronomical Society in Seattle, Washington, USA on 10 January 2019.



Rice University scientists have found Earth most likely received the bulk of its carbon, nitrogen and other life-essential volatile elements from the planetary collision that created the moon more than 4.4 billion years ago. (Credit: Rice University)

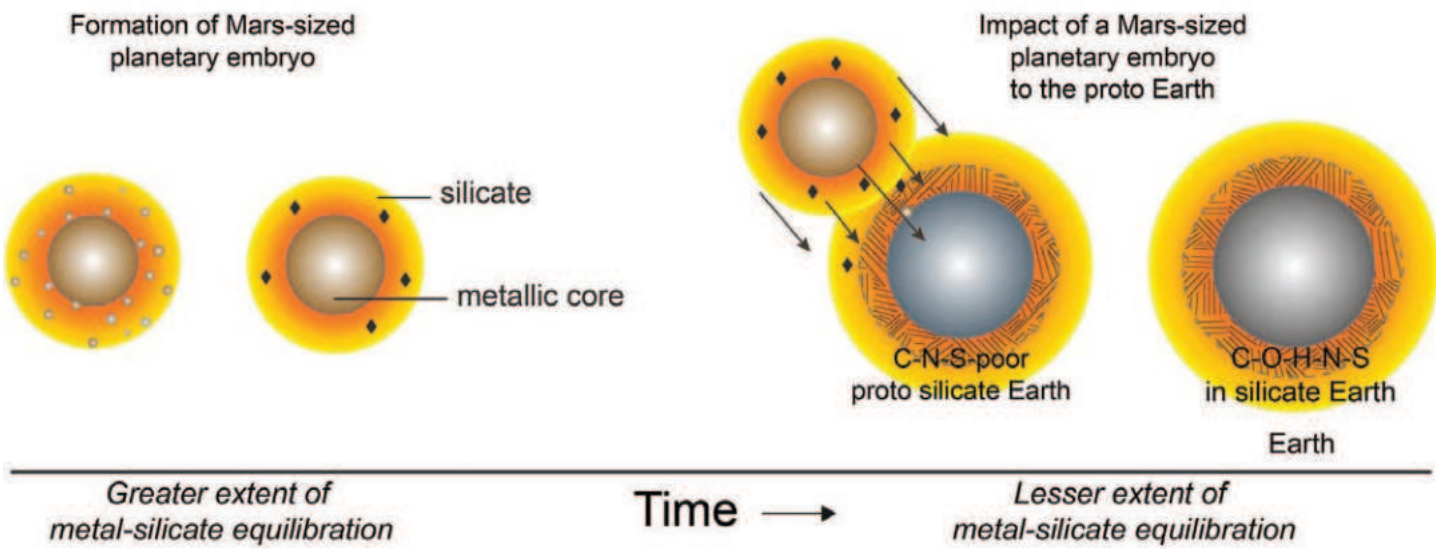
Earth's life-forming elements came from planetary collision that created the Moon

There are many theories to explain the origin of life on Earth, but till recently there was no accepted theory to account for the existence of the elements sulphur, carbon and nitrogen - essential for life - on Earth. Now a team of researchers led by Damanveer Grewal, a fourth-year Ph.D. student in the Department of Earth, Environmental and Planetary Sciences at Rice University in Houston, Texas, USA, have theorised that Earth most likely received the bulk of its nitrogen, carbon and other life-essential volatile elements from the planetary collision that created the Moon more than 4.4 billion years ago.

The Earth has two distinct parts - the central core and the non-core portion that makes up the mantle and surface. Early Earth was a little like Mars is today. It had a core and a mantle, but its non-core portion was very poor in volatile elements such as nitrogen, carbon and sulphur. Elements in the non-core parts of our planet can intermingle with each other, but they never interact with the elements of the core.

According to one theory, special kinds of meteorites, called carbonaceous chondrites, slammed into Earth and gave our planet these volatile elements. This idea rests on the fact that the ratios of different versions — or isotopes — of nitrogen, carbon and hydrogen seem to match those found on these meteorites. So, proponents of the theory argue, the meteorites must be the source of these elements.

But this theory fails to account for the observed ratio between carbon and nitrogen. While the meteorites have about 20 parts carbon to one-part nitrogen, Earth's non-core material has about 40 parts carbon to each part nitrogen. So, the study authors' group decided to test another theory: What if another planet brought the goodies? If



A schematic depicting the formation of a Mars-sized planet (left) and its differentiation into a body with a metallic core and an overlying silicate reservoir. The moon-forming collision of such a planet with the growing Earth (right) can explain Earth's abundance of both water and major life-essential elements like nitrogen, carbon and sulphur, as well as the geochemical similarity between Earth and the Moon. (Credit: Rajdeep Dasgupta)

such a collision happened, the two planetary cores would have merged and the two mantles would have merged, Grewal argues.

To test their theory, Grewal and his colleague Rajdeep Dasgupta set out to create a possible planet that could have collided with our own. They created the high-temperature, high-pressure conditions under which a planet's core might form, in the lab, in a special kind of furnace. In capsules of graphite (a form of carbon), they combined metallic powder (which represents the core and includes elements such as iron bound to nitrogen) with different proportions of silicate powder, meant to mimic the hypothetical planet's mantle.

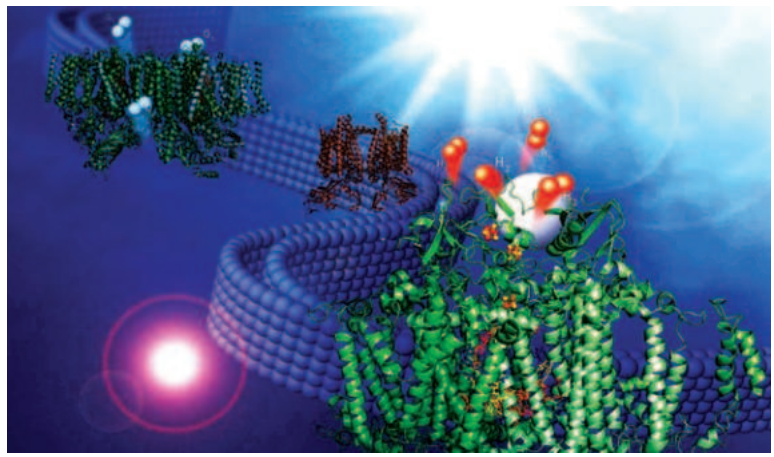
From their studies they found that carbon is much less willing to bond with iron in the presence of high concentrations of nitrogen and sulphur, while nitrogen bonds with iron even when a lot of sulphur is present. So, for nitrogen to be excluded from the core, and be present in other parts of the planet, it should have contained very high concentrations of sulphur, Grewal says.

Using this information, along with the known ratios and concentrations of elements both on Earth and in non-terrestrial bodies, Dasgupta, Grewal and Rice postdoctoral researcher Chenguang Sun designed a computer simulation to find the most likely scenario that produced Earth's nitrogen, carbon and sulphur (*Science Advances*, 23 January 2019 | DOI: 10.1126/sciadv.aau3669). Finding the answer involved varying the starting conditions, running approximately 1 billion scenarios and comparing them against the known conditions in the solar system today.

After running 1 billion simulations, they found that the scenario that made the most sense — the one that had the most probable timing and could lead to a correct ratio of carbon to nitrogen — was one that fitted with a collision and merger of Earth with a Mars-size planet that contained about 25 to 30 percent sulphur in its core. Dasgupta says it does not appear that Earth's bulk silicate, on its own, could have attained the life-essential elements that produced our biosphere, atmosphere and hydrosphere.

Plant protein complexes tapped to produce hydrogen from water

Researchers from the US Department of Energy's (DOE) Argonne National Laboratory have found a new way of extracting hydrogen from water using a combination of two membrane-bound plant protein complexes and sunlight. They utilise a chemical reaction pathway central to plant biology to form the backbone of a new process that converts water into hydrogen fuel using energy from the Sun (*Chemical Science* 29 October 2018. DOI: 10.1039/c8sc02841a). According to the researchers, sunlight-driven water splitting provides a simple pathway to solar-powered production of hydrogen, a clean and renewable energy source that can replace carbon-based fossil fuels and help provide for ever-increasing global energy demands.



This image shows two membrane-bound protein complexes that work together with a synthetic catalyst to produce hydrogen from water. (Credit: Olivia Johnson and Lisa Utschig)

Many current strategies to achieve these so-called "solar fuels" are inspired by Nature's photosynthetic machinery that converts light energy to chemical energy. In normal oxygenic photosynthesis in which plants give off oxygen in presence of sunlight, two protein complexes called Photosystem-I and Photosystem-II are involved. These two protein complexes are Nature's solar energy converters that flawlessly manage photon capture and conversion processes in plants, algae, and cyanobacteria to drive liberation of oxygen and carbon fixation during photosynthesis. Photosystem-I is a membrane protein that can use energy from light to feed electrons to an inorganic catalyst that makes hydrogen. However, this part of the reaction represents only half of the overall process needed for hydrogen production. Argonne researchers Lisa Utschig and her colleagues built on an earlier study that examined Photosystem-I, a membrane protein that can use energy from light to feed electrons to an inorganic catalyst that makes hydrogen. They used a second protein complex called Photosystem II that uses energy from light to split water and take electrons from it, and were able to take electrons from water and feed them to Photosystem-I.

In plants, the two protein complexes are embedded in thylakoids, which are membrane-bound compartments like those found inside the oxygen-creating chloroplasts in higher plants. They are the site of the light-dependent reactions of photosynthesis. "The membrane, which we have taken directly from nature, is essential for pairing the two photosystems," Utschig said. "It structurally supports both of them simultaneously and provides a direct pathway for inter-protein electron transfer, but doesn't impede catalyst binding to Photosystem-I."

One additional improvement involved the substitution of cobalt or nickel-containing catalysts for the expensive platinum nanoparticle catalyst that had been used in the earlier study. The new cobalt or nickel catalysts could dramatically reduce potential costs. The beauty of this design is in its simplicity — you can self-assemble the catalyst with the natural membrane to do the chemistry you want, says Utschig.

Through this work, the researchers demonstrated that "it is feasible to bind synthetic molecule catalysts to thylakoid membranes and make a functional, inexpensive solar fuel producing system, addressing a key challenge of scalability for making solar fuels a viable energy source". According to the researchers, this work provides the basis for future studies and points to a possible means to enhance photosynthetic efficiency toward solar fuel production by creating an alternative electron transfer pathway during downregulation of photosynthesis under high light intensities.

DD Science & India Science - Two National Science channels launched

Department of Science and Technology (DST), Government of India launched two national level initiatives in the field of science communication, DD Science and India Science on 15th January 2019 in Doordarshan Studio, Doordarshan Bhawan, Mandi House, Copernicus Marg, New Delhi.

DD Science is a one-hour programme slot on Doordarshan National channel, being telecast from 5 pm to 6 pm, Monday to Saturday, half-an-hour each in Hindi and English. It is an initiative of the Department of Science and Technology (DST), Govt of India, implemented and managed by Vigyan Prasar (VP) in collaboration with Doordarshan/Prasar Bharati. DD Science programmes can be accessed on any DTH platform. The channel may be scaled up to a fully-fledged channel in the future.

This platform is dedicated to science and technology knowledge dissemination, with a strong commitment to spreading scientific awareness, especially with Indian perspectives, ethos and cultural milieu. Doordarshan is the only terrestrial channel in India and covers the entire country. More importantly, Doordarshan has the highest penetration in smaller towns and in rural India. DD Science will get to benefit from this massive reach and will be able to disseminate science content to the masses.

DD Science programmes comprise documentaries, studio-based discussions, science news roundups, hands-on science demonstrations, popular talks and short films. For the benefit of viewers, all films aired on DD Science, shall also be made available on India Science – an internet-based science channel. Both the initiatives are supported by National Council of Science and Technology Communication (NCSTC), DST.

Union Science and Technology Minister, Dr Harsh Vardhan addressing the audience

India Science (www.indiascience.in) is a 24×7 Internet-based science TV channel, initiated by the Department of Science and Technology (DST), Govt of India, implemented and managed by Vigyan Prasar (VP). It is a bilingual Channel in Hindi and English. It can be accessed on any internet-enabled device – laptop, desktop, smartphones (Android/iOS), smart TVs, etc. This video platform is dedicated to science and technology knowledge dissemination, with a strong commitment to spreading scientific awareness, inculcating scientific temper among the citizen. The India Science mobile App can be downloaded from the Google Play Store and Apple Store. For further details, please visit www.indiascience.in

(L-R) Ms Supriya Sahu, DG Doordarshan; Shri Shashi Shekhar Vempati, CEO Prasar Bharati; Shri Amit Khare, Secretary, I&B; Dr Harsh Vardhan, Hon'ble Union Science & Technology Minister; Prof Asutosh Sharma, Secretary, DST; Shri Rajeev Singh, Member Finance, Prasar Bharati; and Dr Nakul Parashar, Director, Vigyan Prasar at the lauch fuction of Science Channel

Two new science communication platforms were launched by the Union Science & Technology Minister, Dr Harsh Vardhan. The inauguration programme and the signing of Memorandum of Understanding (MOU) between Vigyan Prasar and Doordarshan/ Prasar Bharati was attended by Secretary DST, Prof Asutosh Sharma, Secretary Information and Broadcasting, Shri Amit Khare, CEO Prasar Bharati, Shri Shashi Shekhar Vempati, Director General Doordarshan, Ms Supriya Sahu, Director Vigyan Prasar, Dr Nakul Parashar and senior officials from DST and Ministry of Information and Broadcasting, scientists, journalists, film makers, and others.

Speaking on the occasion, Dr Harsh Vardhan said, "Developing scientific temperament is a critical necessity in a country of 1.3 billon and these two science

channels will drive that national objective, both through DTH as well as the internet. It would help people understand the benefits of science and integrate it in their daily lives. Recalling the role played by Doordarshan in the pulse-polio campaign back in the 1990s, he said that a channel which reaches out to more than the 92 percent of India's population would be very impactful medium for popularisation of science".

Signing of Memorandum of Understanding (MOU) between Vigyan Prasar and Doordarshan/Prasar Bharati

Prof Ashutosh Sharma, Secretary, DST, said "Lot of quality science is happening in scientific institutions across the country. The fruits of these work need to reach the lay person. The DD Science programmes and India Science online channel would help in the task."

Shri Amit Khare, Secretary, Ministry of Information and Broadcasting, said, "These platforms would be ideal for disseminating the scientific findings across".

Shri Shashi Shekhar Vempati, CEO Prasar Bharati, said "The channels were dedicated to science and will enhance the spirit of enquiry in children".

Ms Supriya Sahu, Director General of Doordarshan, said "DD Science would be Hindi and English in the beginning and efforts would be made to gradually expand its scope to telecast the programmes in other Indian languages as well".

Dr Nakul Parashar, Director, Vigyan Prasar, proposed a vote of thanks.

The two science channels are milestones in the history of science communication in India and the first step in creating a National Science Channel for the country. It will help to elevate science into celebration and bring it close to everyday life.

(Report by: Shri Kapil Kumar Tripathi, Scientist 'F', Vigyan Prasar)

Aloe vera: The "sanjeevani" plant *(Continued from page 24)*

antibacterial properties. Saponins, which are the soapy substances having cleansing and antiseptic properties, form about 3% of the gel.

Pharmacological actions and properties

Healing properties

Glucomannan and gibberellin present in *Aloe vera* interact with growth factor receptors on the fibroblast, thereby promoting their proliferation, which increases collagen synthesis and changes its composition and cross linking. Due to this, it accelerates wound contraction and increases the breaking strength of resulting scar tissue.

Anti-inflammatory action

The anti-inflammatory compounds in *Aloe vera* inhibit the cyclooxygenase pathway and reduces production of prostaglandin E2 from arachidonic acid.

Aloe vera gel has been reported to have a protective effect against radiation damage to the skin (e.g., by way of UV and gamma rays).

Laxative effects

Anthraquinones present in *Aloe vera* latex are potent laxatives. They increase intestinal water content, stimulate mucus secretion and increase intestinal peristalsis.

Antiviral and antitumor activity

Aloe vera stimulates the immune system. The anthraquinone inactivates various enveloped viruses such as herpes simplex, varicella zoster and influenza. Inhibition of the tumour-promoting effects of phorbolmyristic acetate has also been reported which suggest a possible benefit of using aloe gel in cancer prevention .

Moisturising and anti-aging effect

Mucopolysaccharides help in binding moisture into the skin. *Aloe vera* stimulates fibroblast which produces the collagen and elastin fibres making the skin more elastic and less wrinkled. It also has cohesive effects on the superficial flaking epidermal cells by sticking them together, which softens the skin. The amino acids also soften hardened skin cells and zinc acts as an astringent to tighten the pores.

Antiseptic effect

Aloe vera contains six antiseptic agents, namely lupeol, salicylic acid, urea, cinnamoic acid, phenols, and sulphur. They all have inhibitory action on fungi, bacteria and viruses.

Uses for skin

The thick gel is known to be highly beneficial for the skin. It fights dry and flaky skin by keeping it hydrated and moisturised. If the skin is feeling dull and tired, one can use *Aloe vera* gel as a quick face pack.

Though safety and effectiveness have not always been proven, *Aloe vera* has been used in conditions of dermatitis, psoriasis, herpes, skin burns, diabetes (type 2), HIV infection, cancer, ulcerative colitis, ulcers, etc., and its role in wound healing has also been proven. Thus, though *Aloe vera* has a wide spectrum of the properties and uses, some of them could be myths and some of them could be real magic! Some clinical studies reveal the hype associated with *Aloe vera*. Extensive clinical trials are needed to prove the effectiveness of *Aloe vera* under various conditions.