VIGYAN PRASAR

DREAM 2047

November 2019 ● Vol. 22 ● No. 2 ● Rs. 5.00

INDIA INTERNATIONAL SCIENCE FESTIVAL
5-8 NOVEMBER 2019
KOLKATA

2019 NOBEL PRIZES

Nobel Prize in Physics

James Peebles | Didier Queloz | Michel Mayor

Nobel Prize in Chemistry

John B. Goodenough | M. Stanley Whittingham | Akira Yoshino

Nobel Prize in Physiology or Medicine

William Kaelin | Gregg Semenza | Peter Ratcliffe

INSIDE STORIES

EDITORIAL

Nobel and November...

Nakul Parashar

Isn't it interesting that as a coincidence, November witnesses the maximum number of birthdays of famous scientific luminaries. Acharya J.C. Bose, Dr Abdul Kalam, Sir C.V. Raman, Rutherford... the list is quite long as we find that a number of the Noble laureates this year too, have their birthdays in November. Yes, this is how the November-born list gets longer! Amongst the Noble Laureates, this year from the November-born list is the 61-year old New York-based oncologist, Dr William Kaelin Jr., born on born 23 November 1957. He is a professor of medicine at Harvard University and the Dana-Farber Cancer Institute. Dr Kaelin is a specialist in tumour suppressor proteins. In the past, he had won the famous Lasker Award for Basic Medical Research. This year he shares the Nobel Prize in Physiology or Medicine with Peter J. Ratcliffe and Gregg L. Semenza.

Dear readers, by the time this issue reaches your hands, the Fifth India International Science Festival would have either taken off or would be taking off. With more than 28 events, IISF 2019 is expected to have more than 12,000 registered visitors. We, at Vigyan Prasar have been bestowed upon the responsibility as the nodal agency to organise it.

In my previous editorials, I've written quite a bit about this year's IISF and hopefully, we get tangible outcomes from it. Post-IISF, we plan to compile notes and publish a compendium so that actionable items could be enlisted, and a path for what to discuss and act upon in next year's IISF could be put forth. In this regard, UN's 17 sustainable development goals and a number of Government's initiatives where Science & Technology's role is vital, would certainly be discussed. A queue of bullet points of practically realisable things-to-do, would emerge. At this IISF, we're trying to film every event. This way, footage gathered from it would yield us content that could be repurposed. At DD Science and www.indiascience.in (over-the-top), where we are in a constant need for relevant content for short films, this mega event would be a wonderful source for it. Print, electronic, digital and social —this way we'll get all covered.

Oh yes, our foray into Indian languages hasn't stopped. After having set the ball rolling in Bangla, Tamil, Malayalam, Urdu, Kannada, and Gujarati, our next addition to this list is going to be Marathi. That too, in November. Well to enumerate them, monthly newsletters — *Bigyan Katha* in Bengali, *Tajassus* in Urdu, *Ariviyal Paligai* in Tamil, *Shastra Katha* in Malayalam, *Kutuhali* in Kannada and *Jignyasa* in Gujarati have already begun their journey. Manuscripts of texts written originally in these languages are gaining momentum and a few of them have arrived at a stage of getting produced. Vetting, copyediting, typesetting and graphics — all done for a number of them so that we could perhaps launch them at Vigyanika, the Science Lit Festival at the IISF. Stay tuned for much more exciting content in more and more Indian languages.

Besides, one more event is about to happen this year and that is the annular solar eclipse. This will occur on 26 December 2019. The annularity will be visible in a number of Asian countries this time – India being one of them. Cities centred in the path of the annularity include Kozhikode and Coimbatore. Indian cities such as Madurai, Chennai, and Bengaluru will narrowly miss the annular path. Vigyan Prasar has drawn up elaborate programs to cover it and issues of *Dream* 2047 will have stories about them. Stay tuned.

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Published and Printed by Dr. Nakul Parashar on behalf of Vigyan Prasar, C-24, Qutab Institutional Area, New Delhi - 110 016 and Printed at Chandu Press, 469, Patparganj Industrial Estate, Delhi 110 092 Telefax: 22424396, 22526936.

2019 Nobel Prizes in Science

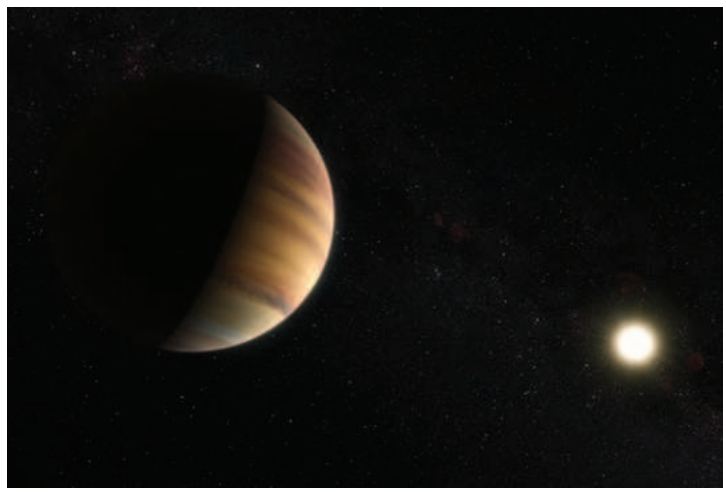
Biman Basu

Physics

Our understanding of the origin and evolution of the universe has undergone many changes in the past 100 years since the Belgian astronomer Georges Lemaître proposed what became known as the Big Bang theory. Cosmic background radiation was discovered in 1965 and turned out to be a gold mine for our understanding of how the universe developed from its early childhood to its present day. On another scale, a major discovery of an Earth-like planet orbiting a sun-type star outside our solar system was made in 1995. Together these discoveries led to a new understanding of our place in the universe.

(From left) James Peebles, Didier Queloz and Michel Mayor

The 2019 Nobel Prize in Physics has been awarded to three scientists "for contribution to our understanding of the evolution of the universe and Earth's place in the cosmos". James Peebles of Princeton University, USA, receives the prize "for theoretical discoveries in physical cosmology" while Michel Mayor of the University of Geneva, Switzerland and Didier Queloz, of the University of Geneva and Cambridge University, UK, have been awarded "for the discovery of an exoplanet orbiting a solar-type star".



This artist's view shows the exoplanet 51 Pegasi b, which orbits a star about 50 light-years from Earth in the northern constellation of Pegasus. This was the first exoplanet around a normal star to be found in 1995.

The Big Bang model describes the universe from its very first moments, almost 14 billion years ago, when it was extremely hot and dense. Since then, the universe has been expanding, becoming larger and colder. Barely 400,000 years after the Big Bang, the universe became transparent and light rays were able to travel through space. Using his theoretical tools and calculations, James Peebles was able to interpret these traces from the infancy of the universe and discover new physical processes.

The results showed us a universe in which just five per cent of its content is known, the matter which constitutes stars,

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planets, trees – and us. The rest, 95 per cent, is unknown dark matter and dark energy – that still remain a mystery and a challenge to modern physics. Peebles' insights into physical cosmology have enriched the entire field of research and laid a foundation for the transformation of cosmology over the last fifty years, from speculation to science. His theoretical framework, developed since the mid-1960s, is the basis of our contemporary ideas about the universe.

In October 1995, Michel Mayor and Didier Queloz announced the first discovery of a planet outside our solar system, an exoplanet, orbiting a sun-type star in our home galaxy, the Milky Way. Before this finding, the only confirmed exoplanet known orbited a pulsar – a dense remnant from a supernova explosion. Using custom-made instruments at the Haute-Provence Observatory in southern France, they were able to see planet 51 Pegasi b, a gaseous ball comparable with the solar system's biggest gas giant, Jupiter. Mayor and Queloz carefully measured a star's velocity using Doppler shift and found that it wobbles back and forth in a tell-tale pattern produced by the gravitational pull of an orbiting planet. This discovery started a revolution in astronomy and over 4,000 exoplanets have since been found in the Milky Way.

This year's laureates have transformed our ideas about the cosmos. While James Peebles' theoretical discoveries contributed to our understanding of how the universe evolved after the Big Bang, Michel Mayor and Didier Queloz explored our cosmic neighbourhoods on the hunt for unknown planets. Their discoveries have forever changed our conceptions of the world and strange new worlds are still being discovered, with an incredible wealth of sizes, forms and orbits..

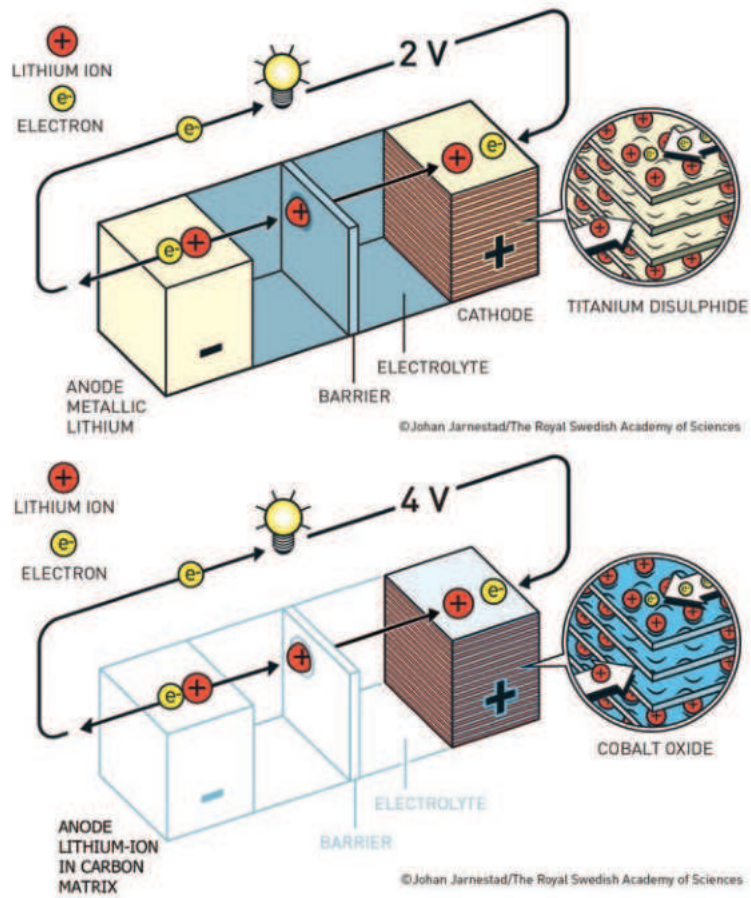
(From left) John B. Goodenough, M. Stanley Whittingham, and Akira Yoshino

Chemistry

The element lithium is the lightest solid element known the first pure sample of the salt of which was obtained by Swedish chemists Johan August Arfwedson and Jöns Jacob Berzelius in 1817. Lithium is a highly reactive element and has to be stored in oil to prevent it catching fire on exposure to moist air or water.

Lithium's high reactivity is also its strength. It catches fire in moist air because it readily releases its outer electron, and this property is utilised in making the lithium battery. It was Stanley Whittingham of Binghamton University, State University of New York, USA, who developed the first functional lithium battery in the early 1970s. The light weight made it possible to pack a lot of lithium into a small space, unlike the large and heavy lead-acid batteries that dominated at the time. Whittingham put metallic lithium in one end and a layered material called titanium disulphide at the other; the titanium had spaces that could capture the flowing electrons. But battery with metallic lithium was too explosive to be viable. As the lithium battery with metallic lithium was repeatedly charged, thin whiskers of lithium grew from the lithium electrode. When they reached the other electrode, the battery short-circuited which often lead to an explosion.

In 1980, John Goodenough of the University of Texas at Austin, USA, doubled the battery's potential by using cobalt oxide in the lithium battery cathode, creating the right conditions for a vastly more powerful and useful battery. Then in 1985, Akira Yoshino of Asahi Kasei Corporation and Meijo University in Japan, succeeded in eliminating metallic lithium from the battery and developed a battery based entirely on



Diagrammatic representation of lithium battery with metallic lithium (top) and lithium-ion (bottom)

lithium ions, which are safer than battery based on pure lithium metal. This made the battery much safer and workable in practice. Lithium-ion batteries are lightweight and powerful as compared with older battery technology and are ubiquitous today, used in cell phones, laptops, electric cars and renewable-energy storage devices that can help address the problems of climate change.

For their ground-breaking research on lithium-ion battery, Stanley Whittingham, John Goodenough and Akira Yoshino have been jointly awarded the 2019 Nobel Prize in Chemistry for their work on "the development of lithium ion batteries". Aged 97, Goodenough is the oldest person to receive a Nobel Prize.

In modern lithium batteries, both the anode and cathode are made of layered materials that can store lithium ions in the gaps or spaces between their layers. When the battery is in use, electrons travel from the anode to the cathode through the external circuit – generating the current required to power whatever device the battery is connected to. At the same time, the positive lithium ions travel through the electrolyte from anode to cathode, where they are again stored. When the battery is recharged, the reverse process takes place with the electrons and lithium ions flowing back to the anode.

Physiology or Medicine

When we talk of life on Earth, we know how important oxygen is to our survival. Animals and humans need oxygen to convert food into useful energy. The fundamental question of how cells sense oxygen has implications for several biological processes including development of embryo, cancer, stroke, diabetes, and other ischemic diseases. No wonder, this is an important scientific mystery that researchers have been trying to crack for many years. Yet, despite the publication of hundreds of papers on this subject, till recently there was no clear consensus regarding what the cellular oxygen sensor is, or even the number of sensing mechanisms there might be. Now scientists seem to have solved the mystery.

The Nobel Prize in Physiology or Medicine for 2019 has been awarded to three scientists – cancer researcher William Kaelin of the Dana-Farber Cancer Institute and Harvard Medical School, Boston, Massachusetts, USA; physician-scientist Peter Ratcliffe of the University of Oxford and the Francis Crick Institute, London, England; and geneticist Gregg Semenza of the Johns Hopkins University School of Medicine, Baltimore, Maryland, USA, "for their discoveries of how cells sense and adapt to oxygen availability".

The body's tissues can be deprived of oxygen during exercise or when blood flow is interrupted, such as during a stroke. Cells' ability to sense oxygen is also crucial for the proper growth of a developing foetus and placenta, and also in tumour growth, because the mass of rapidly growing cells can deplete oxygen in the interior of a tumour.

During researches carried out in the 1990s, the three scientists, working independently, revealed the chain of molecular events that allow cells to detect and respond to different levels of oxygen. They had discovered the molecular processes that cells go through to respond to oxygen levels in the body. They found that central to this is a mechanism involving a protein complex called hypoxia-inducible factor (HIF) and a gene called VHL.

The work of the three scientists has helped researchers to understand how the body detects and adapts to low oxygen levels by, for example, making more red blood cells and growing new blood vessels. Their work has established the basis for our understanding of how oxygen levels affect cellular metabolism and physiological function. Their discoveries have also paved the way for promising new strategies to fight anaemia, cancer and many other diseases.

The work of Semenza and Ratcliffe concerned study of the regulation of a hormone called erythropoietin, which is crucial for stimulating the production of red blood cells in response to low levels of oxygen. Semenza and his team identified a pair of genes that encode the two proteins that form HIF and work together to turn on certain genes and boost erythropoietin production when oxygen is low.

Meanwhile, Kaelin's work showed that the VHL gene may also be involved in how cells respond to oxygen, after studying a genetic syndrome called von Hippel-Lindau's disease. This genetic disease leads to dramatically increased risk of certain cancers in families with inherited VHL mutations.

Thanks to the ground-breaking work of the three Nobel Laureates, we know much more about how different oxygen levels regulate fundamental physiological processes. Oxygen sensing allows cells to adapt their metabolism to low oxygen levels: for example, in our muscles during intense exercise. Other examples of adaptive processes controlled by oxygen sensing include the generation of new blood vessels and the production of additional red blood cells. Our immune system and many other physiological functions are also fine-tuned by the oxygen-sensing machinery. Oxygen sensing has also been shown to be essential during foetal development for controlling normal blood vessel formation and placenta development.

The work has led researchers to develop drugs that target oxygen-sensing processes, including drugs for cancer. Drugs that prevent VHL from binding to HIF and causing its degradation are also being investigated as treatments for anaemia and renal failure. Chinese regulators approved the first of these drugs in 2018. ■

(From left) William Kaelin, Gregg Semenza and Peter Ratcliffe

Taming the Stress May Lead to Success

Dr. Anurag Tripathi

Stress counter strategies of the body are primarily meant to protect the body from harm due to stress. The key to counter unnecessary stress lies in the executive cortical centres of the brain. Pre-frontal cortex that lies in the frontal region of the forebrain is considered to be the chief executive officer of the brain that is the key decision-making centre of the brain. Due to less attention on this centre or less awareness of our thought process, brain starts working in mediocrity with activated reward circuitry that lies in limbic components. Mindfulness meditation or getting conscious towards our thoughts empowers the executive cortical centres that ultimately exert its control over rest of the brain with a judicious strategy to combat stress.

Human body is fantastically designed for life processes with the basic principle of survival that is maximum growth and developmental activities with least dissipation of energy. For this vitality, the human body consists of different organ systems like the digestive system, circulatory system, respiratory system, muscular system, and urogenital system, to name a few. These systems individually consist ofdistinct sets of organs and work together in highly coordinated way. This coordination and homeostasis (metabolic equilibrium) is maintained by two complex systems of the body, namely the nervous system and the endocrine system that collectively constitute neuroendocrine system.More recently,the immune system has also been found to be anintegral part of this system; thus the term neuroendocrine-immune system is appropriate for this integral system. This coordinating system of the body acts through specific chemical secretions which are neurotransmitters and neuromodulators secreted from neurons, hormones secreted from endocrine glands, and immunochemicals like cytokines secreted from immune cells. Proper coordination and homeostasis among different systems is sustained through release ofhighly specific quantitiesof these chemicals, which tend to maintain equilibrium.Thus alteration in the level of these chemicals, or imbalance in the chemistry of these chemicals leads to skewed coordination among systems, which results in altered physiological condition of the body that is often seen in stress condition.

Before going into details about the mechanism of stress response in human body, let us consider what stress is and up to what extent it is valuable. Any physical, chemical, emotional, or psychological condition that disturbsthe homeostasis of the body systems is stress. For instance, when a pathogen enters the body, the immune system gets activated, or when we counter any threatening situation, fight-or-flight response of the body gets activated. Stress condition may be imaginary; for example, continuous negative thoughts also trigger the fight-or-flight response of the body because our body does not discriminate between real and hypothetical stress and starts coping with stress through its in-built mechanism without delay, just because its primary goal is survival and conservation of energy through homeostasis becomes secondary. It is worth mentioning here that the strategy of the body to counter the stress at different levels is an evolutionarily conserved phenomenon that evolved to protect the body by inhibiting the energy consuming systems like digestive system and reproductive system and giving maximum energy input to the systems playing a role in coping with stress like heart, muscle, lung, and brain. Our ancestors lived in forests,caves and open spaces and they used to go for hunt, thus they were continuously exposed to adverse conditions and wild life and they needed to be alert and active for their survival. A strong stress response system thus evolved in humans, through millions

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of years as an evolutionary phenomenon, which still persiststoday.

Body components in stress response

Three systems of the body are directly related with stress– the nervous system, the endocrine system and the immune system, which bring about immediate, intermediate and prolonged stress responses in highly coordinated way, depending on the condition (Fig.1). Nervous system is the primary response centre to stress andconsists of central nervous system and peripheral nervous system. Central nervous system comprises the brain and spinal cord, while peripheral nervous system consists of twelve cranial nerves that connect the sense organs to the brain, and spinal nerves that connect the spinal cord to the different organs of the body. The human brain, which is considered to be the most complex organ of the universe, consists of intricate brain components which are connected to one another through highly ordered neural pathways.

The human brain can be divided into three levels:

1. The lowest level or the vegetative level of the brain is the oldest component of brain from the evolutionary point of view and is present in all vertebrate groups from fish to mammals, playing a role in survival of the individuals. It consists of brain stem and reticular formation. The brain stem consists of pons, medulla oblongata, and the mesencephalon; it is responsible for involuntary activities of the body like respiration, heart beat and vasomotor activity. This vegetative level is considered the automatic – pilot control system of the body. The reticular formation is atangle of fibres and nuclei (group of cell bodies within brain), that connects the brain to spinal cord.
2. The mid-level portion of the brain is called the limbic system, which is the emotional control system of the brain. It consists of the thalamus,hypothalamus, amygdala, hippocampus, septal nuclei, cingulate gyrus and pituitary gland.These centres are highly interconnected and bring about emotional and stress responses directly through a chain of biochemical events. This level is also called the mammalian brain which is present in all mammals.
3. The highest and the most sophisticated level of the brain is the neocortex or the new brain which is highly developed in humans and is supposed to separate humans from other species. This brain component is responsible for thought process, analysis, innovation, intuition, creativity, storage of memory and above all, consciousness. However, all three levels of the brain are highly interconnected sending the neural inputs and outputs in both directions and maintaining a homeostasis (Fig.2).

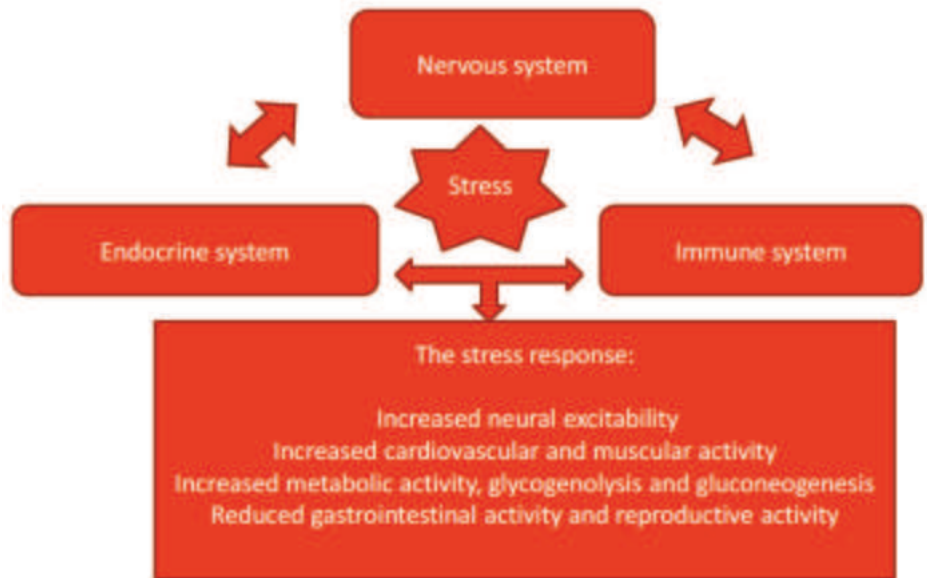

Fig.1. Body systems to combat stress and their responses

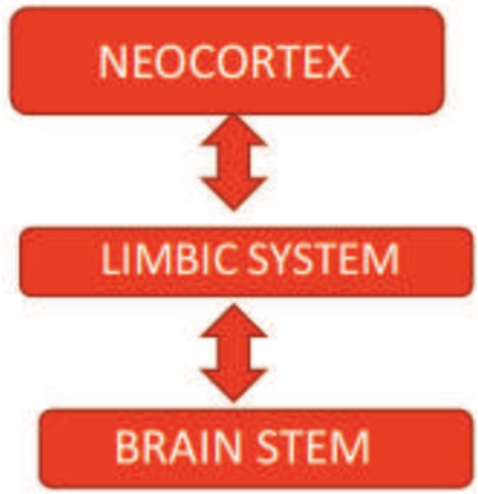

Fig.2. Three levels of brain involved in stress response

Mechanism of stress response

When any sort of stress in form of threat is perceived by our sense organs and relayed to brain, the higher cortical centres or neocortex of the brain starts processing of the input, particularly in the frontal region of the brain and then this information is transmitted to the limbic components for furtheraction. Amygdala of the limbic system, which is also considered as the centre of fear and aggression, is primarily meant to perceive and modulate stress related neuronal inputs. Amygdala is connected withthe neocortex, hippocampus and hypothalamus and exerts its effect on the rest of the brain components. On getting activated after receiving cortical-neuronal inputs,amygdala immediately sends electrochemical signalsto the hypothalamus for further processing; this in turn, activates the autonomic nervous system for immediate response. If the stress condition is sustained for long period, the hippocampus, which potentiates the stress input perceived from amygdala, gets activated. Hippocampus consolidates the short-term memory and sends it to higher cortical centres for storage as a permanent memory.

Activation of autonomic nervous system as an immediate response

After getting input from amygdala, the hypothalamus starts quick response by activating the autonomic nervous system

on the one hand and activating the pituitary gland on the other, for endocrine response. The autonomic nervous system, which encompasses hesympathetic and parasympathetic nervous systems, is responsible for immediate stress response associated with the fight-or-flight response. Sympathetic nerves,whose ganglia (group of cell bodies outside the central nervous system) are located in proximity to the nerve cord, secrete chemicals called catecholamines, specifically epinephrine and norepinephrine, in various organ tissues through neuromuscular junctions to prepare the body for rapid metabolic change and physical movement.Sympathetic drive triggers the energy expenditure by stimulating catabolism where various metabolites are broken down for energy. Sympathetic stimulation accelerates heartbeat and causes vasodilation of arteries in muscles. Epinephrine and norepinephrine secretion stimulates the dilation of pupils, dilation of bronchi in lungs for ventilation, and reduced digestive activity.Released glucose from the liver, energises the body to counter the threat called 'fight-or-flight' response. The overall purpose of this speedy response is to protect the body and this response is lost within 2 to 3 seconds due to counter activity of parasympathetic nervous system, which releases the neurotransmitter acetylcholine and takes the entire response to the normal, such as it reduces heartbeat, relaxes muscle and reduces breathing rate. Thus in normal stress condition, stress response is managed through sympathetic and parasympathetic nervous system and homeostasis is again restored.

Activation of adrenal medulla as an intermediate response

In the intermediate stress response, stimulation of adrenal medulla glandoccurs which also receives neuronal inputs from sympathetic nerves and secrets epinephrine and norepinephrine, thereby increasing its quantity in blood. Therefore, adrenal medulla secretion acts as a back-up system of sympathetic response,and thesecatecholamines remain in circulation up to 20 to 30 seconds, whereas sympathetic catecholamines are lost within 2 to 3 seconds. This situation can be felt when we suddenly see snake, or a dog runs behind us; our body gets extra energised to cope up this adverse condition.

Stressresponse	Reaction	Duration
Immediate	Epinephrine and norepinephrine from sympathetic nervous system	2-3 seconds
Intermediate	Epinephrine and norepinephrine from adrenal medulla	20-30 seconds
Prolonged	ACTH, cortisol, aldosterone, thyroxine, vasopressin through neuroendocrine pathways	Hours, days, weeks

Activation of endocrine system as a prolonged response

When the stress condition persists, or the acute stress turns into chronic stress, prolonged stress response mechanism gets started through endocrine regulation system. Hypothalamus triggers the pituitary gland by secreting the neuropeptide corticotrophin releasing factor (CRF), which stimulates the pituitary cells to release adrenocorticotropic hormone (ACTH). Adrenocorticotropic hormone travels through blood and reaches the adrenal cortex cells to stimulate them to secrete glucocorticoids or cortisol and the mineralocorticoid hormonealdosterone. Cortisol is a major stress hormone that brings about several metabolic changes in body to cope with stress. It increases neural excitability, cardiovascular activity, heart rate, blood pressure, and metabolic activity. It ensures the maximum availability of glucose for metabolic activity thereby inducing glycogenolysis(breakdown of stored glycogen into glucose), gluconeogenesis(breakdown of proteins to generate glucose), and lipolysis(breakdown of fat molecules). Cortisol weakens the immune system by suppressing the lymphocytes, and T cells that produce interleukins.The goal of these physiological alterations is to generate maximum energy to cope with stress.This integrated neuroendocrine system is called 'hypothalamic-pituitary-adrenal' axis (HPA axis).

Along with HPA axis two additional axes function in body as abackup system of HPA axis. They are: (i) Hypothalamic-pituitary-thyroid axis (HPT axis) and (ii) Hypothalamic-vasopressin axis, which get activated in prolonged stress condition (Fig.3). In HPT axis, hypothalamus secrets thyrotropin releasing factor which stimulates the pituitary cells to release thyroid stimulating hormone (TSH). Thyroid stimulating hormone triggers the thyroid

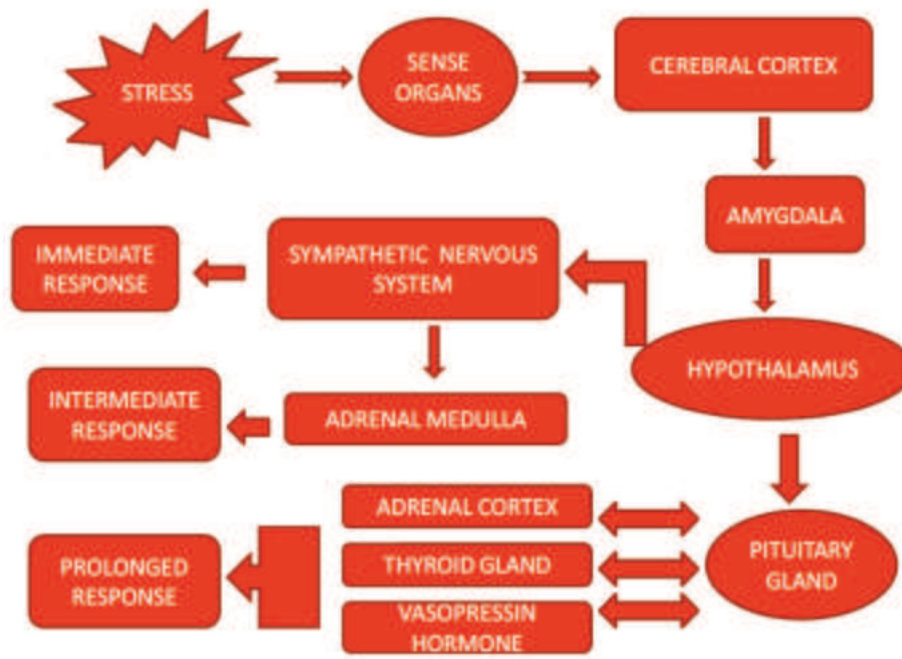

Fig.3. Neuroendocrine pathways in stress response

cells to synthesise and release thyroxine hormone which further augments the activity of cortisol by increasing the basic metabolic rate of the body. Vasopressin hormone is released from posterior pituitary and induces water retention and altered blood volume, ultimately leading to enhanced blood pressure. These prolonged neuroendocrine responses persist up to days and weeks. Thus it is obvious that stress response is related to survival, and human body is endowed with adequate counter mechanisms to cope with stress through immediate, immediate and prolonged responses.

Side-effects of stress response

Although the stress response system hasevolved in the body to counter the threat with the primary objective of survival, prolonged exposure to stress or chronic stress results in many health complications. Excessive levels of cortisol, catecholamines, thyroxine and vasopressin in blood leads to cardiovascular diseases and increased blood pressure. It also leads to increased blood sugar hence increased risk of diabetes. Prolonged exposure to stress leads to indigestion and chronic constipation. It reduces the level of testosterone and alters the menstrual cycle in females. Corticosteroids have receptors in hippocampus that leads to hyper-activation of hippocampus thus impairing normal function of hippocampus in consolidation of permanent memory and adult neurogenesis,which leads to shrinkage of this brain part resultingin cognitive impairmentin the long term. Excess level of epinephrine and norepinephrine in brain leads to reduced level of major mood neurotransmitters, serotonin and dopamine, which leads to many psychiatric disorders like anxiety and depression. Reduced immune response causes illness-like situation. Thus overall, prolonged stress response is harmful to health.

It may be mentioned here that unnecessary thoughts, panic thoughts, jealousy, hypothetical fears, hatred, and heated discussions give the same stress response as a real threatening situation because the stress response system functions through neurochemical and endocrinological pathways that get activated on receiving the stimulus from higher cortical centres, irrespective of the fact whether the stress situationis true or imaginary.

Taming the stress

If the stress condition is real, that is, if there is real threatening situation, the stress response system of the body must get activated because survival is the primary goal.But in modern life style, 80% reasons of stress are due to psychosomatic reasons and wrong attitude. Since the root of stress response lies in higher cortical brain centres, proper awareness at this levelcanbe helpful to counter aroused stress pathways. By adopting afew strategies, stress can be effectively countered and brain and endocrine system can be provoked to attain homeostasis.

1. Physical exercise has been proven to be immediate stress buster. Studies show that aerobic exercise helps build new neurons and connections in the brain, particularly in hippocampus. Exercise or fast walk stimulates the secretion of endorphins which relax the brain and body.
2. Relaxation through yoga practices and mindfulness meditation techniques, a walk on the beach, or listening to classical music is highly effective to counter stress, anxiety and depression; these techniques are now being practised as an alternative medication in many countries.
3. Social interactions and interaction with family members, spending time with pets, and gardening are also effective to combat stress.
4. Laughter and continuous positive thinking reduce the level of cortisol and epinephrine, thus helping in coping with stress.
5. Studies show a direct correlation between feelings of psychological empowerment and stress resiliency. Empowering one with a feeling of control over one's own situation can help reduce chronic stress. Some videogames and apps based on heart rate variability can be effective to control stress level.

Conclusion

It is significant to notice that the aforementioned inherent stress counter strategies of the body are primarily meant to protect the body from harm due to stress. The key to counter unnecessary stress lies in the executive cortical centres of the brain. Pre-frontal cortex that lies in the frontal region of the forebrain is considered to be the chief executive officer (CEO)of the brain that is the key decision-making centre of the brain. Due to less attention on this centre or less awareness ofour thought process, brain starts working in mediocrity with activated reward circuitry that lies in limbic components. Mindfulness meditation or getting conscious towards our thoughts empowers the executive cortical centres that ultimately exert its control over rest of the brain with a judicious strategy to combat stress. During stress condition, high level of epinephrine energises the body and brain; if this energised state is turned towards goal-oriented tasks it can give immense results. During examination or during any live presentation we feel mild stress because enhanced level of epinephrine increases cardiovascular activity to increase blood flow in memory centres of the brain, making us more alert and after few seconds we get relaxed. Thus, mild stress is beneficial in many respects but it must not be turned into chronic stress, and this can be achieved through proper care and awareness as mentioned earlier.

Adoption of Green Building for Sustainable Growth of Rural India

Ashish Suresh Srivastava

"Augmenting Writing Skills for Articulating Research (AWSAR)" is an initiative of the Department of Science and Technology, Govt. of India. It aims to disseminate Indian research stories among the masses in an easy-to-understand and interesting format. Under this initiative, PhD scholars and Post-Doctoral Fellows in science and technology are encouraged to write at least one popular science article during the tenancy of their fellowship and to participate in a national competition. For Ph.D. researcher, the top three essays are awarded a cash prize of ₹1,00,000, ₹50,000 and ₹25,000 respectively. For Post-Doctoral Fellows, the best essay is awarded the cash prize of ₹1,00,000. Apart from these, top 100 entries from Ph.D. and top 25 entries from Post-Doctoral Fellows are awarded ₹10,000 each, along with Certificate of Appreciation. For more information log-on to https://www.awsar-dst.in/

The article "Adoption of Green Building for Sustainable Growth of Rural India" written by Ashish Suresh Srivastava was awarded first prize in Ph.D. scholar category in AWSAR 2019.

Travelling to hometown creates excitement in a person of any age, education and status. It was my summer vacation after completing first year of Master's in Civil Engineering. The only way to reach my tiny village "Piapali" in Bastar district of Chhattisgarh state in central India was by train, with breaks in journey, first at Raipur and then at Jagdalpur. It was a luxury to travel in AC 3-tier compartment as my ticket was sponsored by my grandfather to visit him at Piapali., it was a pleasant I realised after getting down from the train in the scorching heat of central India how pleasant it was sitting in the air-conditioned train, thinking about the beauty of nature and village life. Since; I had to board a connecting train from Raipur to Jagdalpur, I had no other choice but to sit in the waiting room which felt like a sauna in the middle of May. After 16 hours of tiring journey from Raipur I reached Jagdalpur station. We reached our village and excited and happy to meet my grandmother, relatives and cousins. It was 8 p.m. when suddenly the electricity supply went off. On enquiry, I learnt that our village has 16 hours of load-shedding and electricity would resume only after that. I had a sleepless night with a single fan which was running on inverter and the entire family was compelled to sleep in one room, which was suffocating due to lack of ventilation in the room.

Next morning, I realised that it was difficult to manage regular chores and potable water was sourced from Indravati river near our house. Staying in an urban area with all luxuries of basic necessity like 24×7 water, electricity and other utility services, I never thought about the wastage of electricity and water until I experienced it myself. I realised that a balanced utilisation of natural resources defines sustainability for long-term human existence. The balance between urban and rural areas needs to be addressed for overall progress of any country. This thought gave birth to a need to carry out research and development in sustainability. After returning home, I zeroed

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in on a research topic for my thesis.

After going through journal papers, research articles, technical magazines, books and further discussions with my guide, I started my journey on sustainability. Though there was a lot of research available, there were very few papers on Indian spectrum for green buildings. After researching I got to know that there were two major institutions in India working on green building, out of which one was state sponsored and known as Green Rating for Integrated Habitat Assessment (GRIHA) and the other was Indian Green Building Council (IGBC), a privately sponsored authority under the Indian Industry (CII). There were a few others like Leadership in Energy and Environment Design (LEED), Excellence in Design for Greater Efficiencies (EDGE) and World Green Building Council (WGBC).

Meanwhile, in the first half of my thesis tenure I went to Vishakhapatnam to get training from IGBC and further appeared for the IGBC accredited professional exam and cleared it in the first attempt with flying colours. My next goal was to take training in GRIHA, which I accomplished in Mumbai. After gaining a thorough knowledge of green buildings I could not find a platform to calculate utility savings or reduced carbon footprints of green building as compared to the base case. Only EDGE had an online platform and was giving results in an output format for submissions to concerned authorities. However, since EDGE is funded by International Finance Corporation (IFC) it lacked India-specific requirements. Following a discussion with my guide to make a soft computing technique for IGBC and GRIHA code of practice, I zeroed upon making a soft computing tool in Microsoft Excel for my Master's thesis for appropriately calculating the credits with respect to the IGBC abridged reference guide and preparing a case study using the same programme and comparing with an actual green certified building.

The study included the green building concept like sustainable site planning, building design optimisation, energy performance optimisation, renewable energy utilisation, water and waste management, solid waste management, sustainable building material and construction technology, health, wellbeing and environmental quality. The benefits of green building have emerged which will prevent pollution, save energy and thereby save on natural resources and expenditure during operation which results in approximately in 60% reduction in energy consumption. Efficiency in offices and homes increases with natural non-glare light and proper ventilation in the room, which results in reduction of respiratory diseases by 20% and performance of the occupants up to 25%, which finally results in low utility demands in green building.

The environmental benefits include emission reduction, water conservation, strong water management, temperature moderation and waste reduction. The economic benefits include energy and water savings, increase in property value due to lower operating cost and maintenance of building and decreased infrastructure strain, i.e., less demand on local power grid and water supply. The indirect benefit includes improved attendance, increased productivity, sales improvement and development of local talent pool. The social benefit includes improved health due to better air circulation, proper lighting, lesser temperature variance, etc., and attendance due to better environmental conditions, healthier lifestyle and recreation by use of alternatives to personal driving such as bicycling and public transport which also adds to health and benefits of occupants.

After completing my master's thesis in Civil Engineering and ranking 3rd in the university, I was elated and it resulted in building my self-confidence to carry out further research by pursuing a Doctor of Philosophy (Ph.D.) in civil engineering. After taking guidance from my guide, I decided to carry out my study on "Development of web-based decision tool for green building credit rating certification. During the review of various literature in soft computing techniques for green building I carried out a critical appraisal of my literature and zeroed in on the gaps in the literature and thus, defined the statement of problem for my study.

Further to my above study, I found that in applying for green rating to the authorities, one has to engage various agencies in the field of energy modelling, water conservation, green consultants, project architects, project engineers, who thereby prepare large and complex documents to comply with the given intents to achieve the star rating of any green building. I decided to make a tool to meet the demands for quick, simple and free-to-use online web based decision tool to solve the complexities of the hidden methodology of resource efficiencies and cost savings in comparison to the base case without involvement of large expense by use of third-party specialists to prepare and apply for green rating.

My objective of proposed study was to study all versions of GRIHA and IGBC rating system and to find a methodology for appropriate calculations of credit points with respect to requirements as given in abridged reference guide. The above work required me to prepare programming concepts which included a complex conditional statement, looping of the same, implementation of logic flow diagram for problem solving and communications. After studying the above, I realised the need to master myself programming tools like PHP: Hypertext JQuery, Cascading style sheets (CSS), Hypertext Mark-up Language (HTML), Dot Net framework (.NET), C Sharp .NET, Dynamic-Link Library (DLL), Microsoft SQL Server and Java Script. On the hardware front, I had to study and find out the methods of storing data inputs through online and preparation of reports in the backend for further research and development, front-end reports for the users. I decided to make a close-source online programme which could be used as to avoid copying and redistribution of my programme. The above study also required testing and deployment optimisation by the way of algorithmic efficiencies, resource allocation, virtualising, terminal server testing, power management, data centre power optimisation technique, operating system support and means of storage and cloud computing.

The expected outcome of my study will be a web-based decision tool for all green rating systems to meet the demands of easy, faster, reliable and affordable tool which shall be used to plan and estimate the design of resource efficiency in order to boost green building growth in emerging markets and backend data for in-house research and development. My dream to balance the gap of consumables like water, electricity and for sustainability in rural areas shall come true by adaptation of green building certification in urban area which will reduce the demand of water and electricity and which can be directed to the villages of India. ■

Indian Institute of Science and the Sandal Soap

N. Munichandraiah

Sandalwood is one of the oldest knowån perfumery materials with over 2,000 years of history. The dried sandalwood is sweet-smelling, and it is known as chandan in Sanskrit. The aroma comes from the dry wood, which contains the chemical santalol. Typically, sandalwood oil extracted by steam distillation of dry sandalwood contains more than 80% santalol and quality of such oil is considered as good.

Soaps, cosmetics, fragrances, detergents, etc., have become essential commodities of modern living. Society changed from the practice of using clay, pumice stone, oil, etc., for cleaning human body during bathing to using soaps long ago. Soaps and detergents safely and easily remove germs, soils and other contaminants, and help us to stay healthy and keep our surroundings pleasant. Making of soaps dates back thousands of years. Mesopotamian civilization (3200 BC) used a concoction of animal fat and tree ash to produce soap. Egyptians were believed to be the first group of people that bathed regularly. The soap recipe was found on Ebers Papyrus (1500 BC) which was a medical document. It was used to treat skin diseases and personal cleaning. In India, the popular sandal soap is a contribution of Indian Institute of Science, Bengaluru.

Making soap

The chemical process of making soap is known as saponification. Long-chain fatty acids generally exist as triglycerides, which are esters formed by combination of fatty acids and glycerol. They can be either of plant origin (linseed oil, castor oil, coconut oil, etc.,) or animal origin (tallow from cattle and sheep). When triglycerides in fats or oils react with an aqueous solution of sodium hydroxide or potassium hydroxide, they are converted into sodium or potassium salts of fatty acids (soap) and glycerol. Soap is made up of molecules with two very different ends. One end of soap molecules love water – they are hydrophilic. The other end of soap molecules hate water – they are hydrophobic. When dissolved in water, soap molecules form micelles with water-hating tails orienting towards the grease or dirt particles and the water-loving heads outwards, thus collecting and removing the dirt with ease. Over time, humans had

Figure 1. (top) Indian Institute of Science and (bottem) Department of General and Applied Chemistry (presently, Department of Inorganic and Physical Chemistry).

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cultivated the habit to enjoy not only the ease of cleaning skin, clothes, etc., by soaps to stay healthy, but also the fragrance that lingers. The Indian Institute of Science (Figure 1a), in particular, the Department of General and Applied Chemistry (the present Department of Inorganic and Physical Chemistry (Figure 1b) played a key role in developing the famous Mysore Sandal Soap a century ago.

Figure 2. Visionary Jamsetji Nusserwanji Tata (3 March 1839-19 May 1904)

Establishment of IISc

The Institute has its origin from the vision of Jamsetji Nusserwanji Tata (Figure 2), who decided to establish a Research Institute of Science in the country and submitted the proposal to the Government of India. Swami Vivekananda (Figure 3), who had met Tata on a voyage to Chicago, strongly supported Tata's proposal. Prof. William Ramsay, inventor of noble gases and 1904 Nobel laureate in chemistry (Figure 4) submitted a detailed report and recommended Bengaluru as suitable for establishment of the research institute. The establishment of the Indian Institute of Science was approved by the Government in 1909 with Prof. Morris Travers (Figure 5), an associate of Sir Ramsay, as the Director. The academic and research activities commenced in the year 1911. The buildings that were constructed at that time include the present Inorganic and Physical Chemistry Department (Figure 1b) in addition to the other buildings such as the iconic Main Building (Figure 1a).

Figure 3. Swami Vivekananda (12 January 1863-4 July 1902)

Figure 4. Sir William Ramsay (2 October 1852-23 July 1916)

Figure 5. Professor Morris Travers (24 January 1872-25 August 1961)

The research activities of the Institute started producing results by the year 1914, as it was evident from the launch of the *Journal of Indian Institute of Science* (*JIISc*) that year. The journal was probably started by Prof. Travers to document the results of the Institute's research and the first article, which was on boron chemistry, was authored by him and his co-workers. Several researchers, probably Ph.D. students, of chemistry contributed to the first volume of *JIISc*. Steam distillation of wood of several Indian trees was an important research activity of organic chemistry researchers of the Department of General and Applied Chemistry, which was evident from various publications that appeared in *JIISc* during 1918-1920.

Sandalwood oil

Sandalwood is one of the oldest known perfumery materials with over 2,000 years of history. Sandalwood with the botanical name *Santalum* is known to prevail mainly in South Asia and Australia in two broad categories, namely *Santulum album* (white sandalwood) and *Petrocarpus santalinus* (red sandalwood). The dried sandalwood is sweet-smelling, and it is known as *chandan* in Sanskrit. The aroma comes from the dry wood, but not from flowers and leaves although they also look beautiful. The fragrant nature of sandalwood is due to the presence of the chemical santalol in the wood. The quality of sandalwood oil is determined by the levels of α- and β-santalol, the α-isomer being more abundant than the β-isomer. Typically, sandalwood oil extracted by steam distillation of dry sandalwood contains more than 80% santalol and quality of such oil is considered as good.

Figure 6. A sandalwood sapling on the Institute campus

Sandalwood was originally used at funeral ceremonies, burnt so that the scent could carry the soul into the next stage. In ancient Buddhist traditions, it was used as a meditation tool to stimulate sensuality, invoke tranquillity, inculcate divine thoughts and promote relaxation. In Ayurveda, sandalwood is used to provide energy and enthusiasm. The sandalwood paste (*srigandh*) is considered as sacred.

In India, out of a total area of 9,000 sq. km area of sandalwood forests, 8,200 sq. km. is in Karnataka and Tamil Nadu. In Tamil Nadu, sandalwood forests are spread across several districts of Salem,

Figure 7. (a) Maharaja Krishnaraja Wodeyar IV (4 June 1884-3 August 1940), (b) Sir M. Visveswaraya (15 September 1861-12 April 1962), and (c) Mr. Sosale Garalapury Sastry (November 1899-22 September 1955)

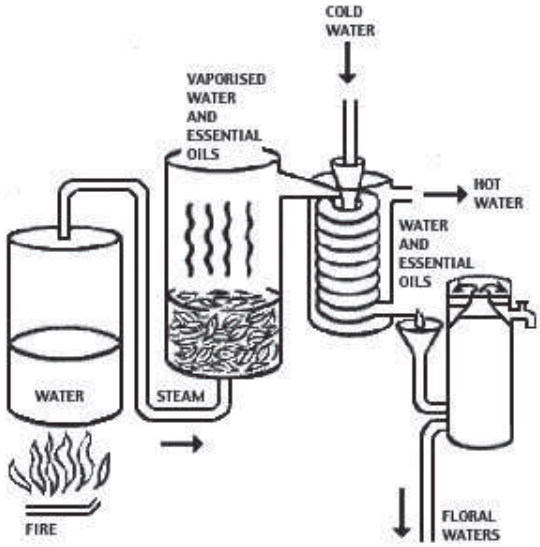


Figure 8: Schematic diagram of steam distillation process

Dharmapuri, Erode, Tiruvannamalai, Vellore, the Nilgiris, Villupuram, Madurai, Virudhnagar and Tirunelveli. Apart from Karnataka and Tamil Nadu, sandalwood trees are also found Kerala, Andhra Pradesh, Odisha, Madhya Pradesh, Maharashtra and Rajasthan. The region around Mysore has rich with sandalwood plantations. Dry sandalwood logs had a high demand abroad in the beginning of 20th century and were mainly exported from the princely state of Mysore to Europe. During World War I, sandalwood could not be exported, and huge quantities of logs remained unused around Mysore. The Maharaja of Mysore, Krishnaraja Wadiyar IV (Figure 7a) asked one of his Dewans, Sir M. Visvesvaraya, (Figure 7b), popularly known as Sir MV, to find a method of making use of the logs of sandalwood. Sir MV approached the IISc, which was in its infancy, and sought the help of the General and Applied Chemistry Department. Mr. Sosale Garalapury Sastry (Figure 7c), who was involved in research in the Department, was identified to explore a suitable method of extracting oil from sandalwood. He succeeded in producing sandalwood oil by steam distillation (Figure 8) and also in preparation of soap using the sandalwood oil as an essential component. Sir MV presented the soap to the Maharaja of Mysore, who was impressed by its fragrance He decided to start a soap manufacturing industry and gave the task of setting up the industry to Sir MV. Mr. Sastry was sent to Bombay (now Mumbai) and then to UK to gain the technical knowledge of production of soaps on industrial scale.

The Mysore Soap Factory started functioning in Bengaluru in the year 1916 and the commercial soap was launched in the market in 1918. Mr. Sastry was responsible in designing the oval-shaped Mysore Sandal Soap with *sarabha* as the emblem (Figure 9). *Sarabha*, with lion's body and elephant's head, combines the virtues of wisdom, courage and strength. The century-old emblem and shape of the Mysore Sandal Soap remain the same even today. The Mysore Soap Factory later was expanded, and it became Karnataka Soaps and Detergents Limited with a large number of products such as talcum powder, incense sticks, detergents, etc., in addition to soaps employing sandalwood oil. The Bengaluru factory is located close to the Institute. Mr. Sastry became popular during his period and he was affectionately known as Soap Sastry.

Figure 9 : Mysore sandal soap with sarabha as its emblem

In his address at the Indian Science Congress held at Lahore in 1918, Prof. G.J. Fowler, Professor of Biochemistry in the Department of General and Applied Chemistry at IISc, stressed the importance of training students in all aspects to contribute to industries. He said it was important for educational and research institutions to produce graduates who could successfully devote themselves to applied chemistry. There was a need for definite and specific training for those who intended to take placement in industrial developments for which plenty of scope existed during that period. This might be the reason for naming the chemistry department as Department of General and Applied Chemistry.

At the Institute, methods were tried out in a modest way for a limited number of industrial research paths. Prof. Fowler suggested setting up of a model plant before transferring the know-how to industry. He said sandalwood oil was a source of profit to Mysore and the production of soap was ready in 1918. The knowhow for sandalwood soap production was transferred by the Department of General and Applied Chemistry of Indian Institute of Science to a factory in Bengaluru. Thus, Mysore Sandal Soap was one of the first industrial products developed by the Department General and Applied Chemistry of Indian Institute of Science, more than a century ago. ■

Recent Developments in Science and Technology

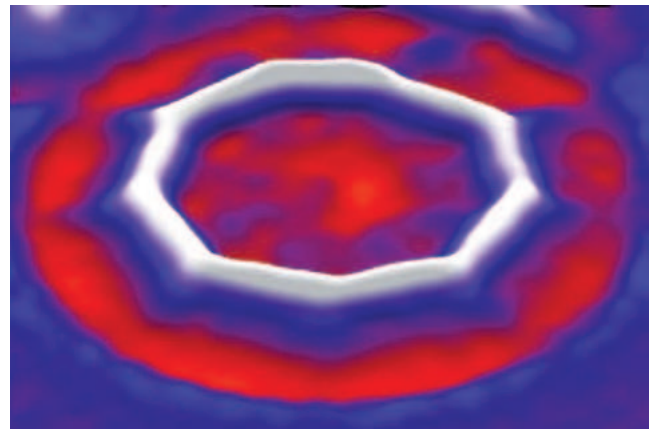
Biman Basu

Pomegranate is a fairly common fruit which is known to be nutritious – rich in vitamin C, potassium, and fibre. The fruit has also been claimed to have anti-aging properties, but up to now, scientific proof has been fairly weak. Now, scientists have discovered that urolithin A (UA), a metabolite of biomolecules found in pomegranates formed by microbes in the gut, enables muscle cells to protect themselves against one of the major causes of aging.

Scientists create a new form of carbon

Carbon is one of the most common elements in the universe, and depending on how the carbon atoms are joined, different carbon molecules, called allotropes are formed. These different forms of carbon usually have strikingly different properties. For example, diamond and graphite are both made of pure carbon, but their properties are totally different. Diamond is extremely hard and brilliant, but graphite is soft and dark. The difference in properties arise from the way the carbon atoms are bonded within the molecule. In diamond, each carbon atom bonds with four other carbon atoms around it forming a rigid structure, which makes it strong and hard, whereas in graphite, each carbon atom bonds with three of its neighbours forming layers which can slide over each other making graphite a soft material. Carbon has several other allotropes such as graphene, fullerene, and carbon nanotubes with different structures and properties.

Several cyclic carbon compounds such as benzene (C_6H_6), cyclopentane (C_5H_{10}), cyclohexane (C_6H_{12}), cycloheptane (C_7H_{14}), cyclooctane (C_8H_{16}), cyclodecane ($C_{10}H_{20}$), etc., are also known but all of them also contain hydrogen atoms. Chemists have been trying to prepare cyclic molecules containing only carbon atoms called cyclocarbons in which each carbon atom is linked with only two other carbon atoms arranged in a closed loop or ring. Researchers with IBM Research in Zurich, Switzerland and the University of Oxford, UK, have recently announced the successful creation and imaging of a ring structure for the first time ever, revealing 18 carbon atoms linked together to form a complete ring – yet another form of carbon (*Science*, 15 August 2019 | doi:10.1126/science.aaz1461). The C18 molecule is the smallest cyclocarbon made from carbon atoms, which is predicted to be a thermodynamically stable carbon ring.



A 3D-image of the carbon-18 molecule made with an atomic force microscope. (Credit: IBM Research)

The researchers were able to produce the C18 ring by eliminating carbon

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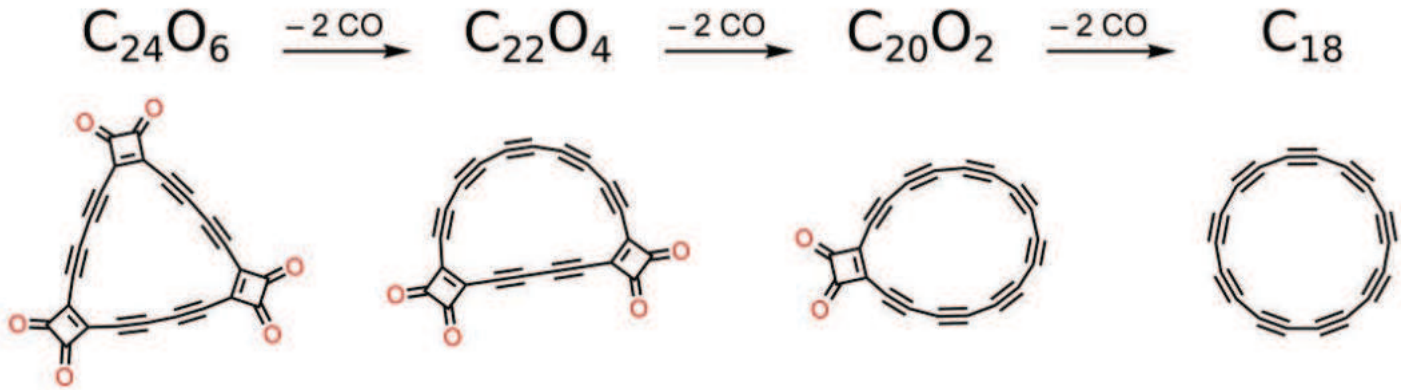


From left to right, precursor molecule $C_{24}O_6$, intermediates $C_{22}O_4$ and $C_{20}O_2$ and the final product cyclocarbon C18 created on surface by dissociating CO masking groups using atom manipulation. (Credit: IBM Research)

monoxide from a cyclocarbon oxide molecule $C_{24}O_6$ – the triangular cyclocarbon oxide compound where 18 carbon atoms are bonded to six carbon monoxide molecules. They used atom manipulation on a bilayer of sodium chloride (NaCl) on a copper plate (Cu), chilled in a vacuum chamber at 5 Kelvin to eliminate the carbon monoxide entities from a cyclocarbon oxide molecule $C_{24}O_6$. This provided an inert surface that kept the structure stable where the compound was formed by eliminating carbon monoxide (CO) molecules off the structure, leaving just the ring of carbon atoms behind with a structure of carbon atoms with an alternating triple and single bonds. The researchers used electric currents to "peel away atoms the way a sculptor carves away the excess stone to reveal a sculpture underneath". Characterisation of C 18 cyclocarbon by high-resolution atomic force microscopy revealed the structure with defined positions of alternating triple and single bonds.

According to the researchers, this cyclocarbon's structure suggests that it acts as a semiconductor. This means that it has potential use in electronics. The high reactivity of this allotrope, the very property that made cyclocarbons so difficult to isolate earlier, could be used to create other carbon allotropes and carbon-rich materials.

"Our results", the researchers wrote, "provide direct experimental insights into the structure of a cyclocarbon and open the way to create other elusive carbon-rich molecules by atom manipulation".

Pomegranate chemical can slow down aging

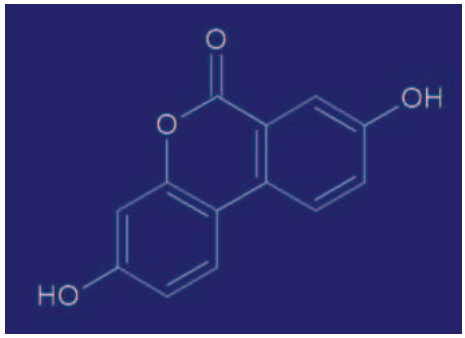
Pomegranate is a fairly common fruit which is known to be nutritious – rich in vitamin C, potassium, and fibre. The fruit has also been claimed to have anti-aging properties, but up to now, scientific proof has been fairly weak. Now, scientists from the Swiss Federal Institute of Technology Lausanne (Ecole Polytechnique Fédérale de Lausanne, EPFL), Switzerland, and the Swiss Institute of Bioinformatics (SIB) have discovered that urolithin A (UA), a metabolite of biomolecules found in pomegranates formed by microbes in the gut, enables muscle cells to protect themselves against one of the major causes of aging. In experiment with nematodes and rodents, reported in 2016, the effect was nothing short of amazing. Result of clinical trials with humans have just been published.

Pomegranates contain biomolecules that can be transformed by microbes in the gut to urolithin A, which enables muscle cells to protect themselves against one of the major causes of aging.

Pomegranate contains ellagitannins, a diverse class of hydrolysable tannins. When ingested, these molecules are converted into urolithin A in the human gut. The researchers found that UA can slow down the mitochondrial aging process. But not everyone produces UA naturally after consuming pomegranate. So, to get around that problem, the team synthesised the compound and used it for clinical trials.

In clinical trials, when UA was orally administered in both single and multiple (4 weeks) daily dosing to 60 healthy elderly subjects in a double-blind, randomised, placebo-controlled study, significant improvement in muscle function was observed. Significantly, there were no adverse effects. There are currently no effective solutions to treat age-related decline in muscle function other than months of exercise (*Nature Metabolism*, 14 June 2019 | doi: 10.1038/s42255-019-0073-4).

This is an important first clinical validation that shows urolithin A could be a promising solution for the management of healthy muscle function during aging. According to the researchers, "Mitochondrial and cellular health declines with age, making these results a pivotal milestone as we explore the full breadth of benefits urolithin A offers for managing human health throughout the aging process".



Urolithin A (Credit: wikipedia.org)

Urolithin A works in the following way: Administration of UA leads to improved mitochondrial function by stimulating mitophagy, a process by which aging and damaged mitochondria are cleared from the cell, leading to the growth of healthy mitochondria – the cell's powerhouse. Mitophagy declines in cells as we age, and the reduction in mitochondrial function in the muscles of the elderly is thought to be one of the main causes of age-related muscle impairment.

According to the researchers, UA is the only known compound that re-establishes cells' ability to recycle defective mitochondria. In young people, this process happens naturally. But as we age, our body starts to lose its power to clean up dysfunctional mitochondria, causing sarcopenia (loss of skeletal muscle mass) and the weakening of other tissues. The Swiss team focussed on slowing, or even reversing, this natural effect of aging and found that administration of UA indeed helps.

A paper published in 2016 had shown that the lifespan of nematode worms exposed to UA increased by 50 per cent – from around 20, to 30 days – when compared with the control group. Likewise, older mice showed 40 per cent better endurance while running after two weeks of treatment with UA.

An innovative life sciences company, based at EPFL's Innovation Park in Ecublens, Switzerland, which has been pioneering scientific breakthroughs in nutrition, has taken up the development of products that meet the health requirements of the aging population. Their products target the reversal of age-related muscle decline by improving the activity of mitochondria. The company hopes to harness the promising results of the recent study to quickly bring synthetic UA to market. ■

Ariviyal Palagai launched in Chennai to further science communications in Tamil

Vigyan Prasar, in association with the Tamil Nadu Science and Technology Centre (TNSTC) launched its Tamil science communications mission, Ariviyal Palagai on 3 August 2019 at the Anna Centenary Library, Chennai. On 3 and 4 August, a two-day seminar titled 'Science Communication, Popularisation and Extension in Tamil: The Road Ahead' was held. Experts in science communication in Tamil from governmental scientific research establishments, publishing sphere, journalists, filmmakers, non-governmental organisations, academia, and the industry, as well as enthusiasts, got together to discuss the road ahead.

First issue of the "Ariviyal Palagai" a Tamil newsletter was release

Speaking at the launch, Dr Mylswamy Annadurai, VP of TNSTC and former director of ISRO said, "We should all come forward to join hands with Vigyan Prasar and ensure that more and more children are inspired to take up science, through the wonderful medium of Tamil language." Dr Annadurai also launched a monthly newsletter, titled *Ariviyal Palagai* and received the first copy.

Dr Mylswamy Annadurai, (former) Project Director Chandrayaan 1 mission inaugurated the seminar

Dr T.V. Venkateswaran of Vigyan Prasar, Dr S. Soundararaja Perumal, Director, TNSTC, Lenin Tamilkovan of TNSTC, Gopal Parthasarathy of Vidyarthi Vigyan Manthan, and science communicator Narmadha Devi curated five discussion forums. The speakers in these forums included Dr V Subramanian, chief scientist, CLRI, Dr Chandrasekaran, IGCAR, Dr Kalaiselvi of CECRI; Prof. Sivaraman of Pi Mathematics Club, former director of AIR, N. Murugan; eminent journalists R. Venkatesh, S. Neethirajan, Karthikai Selvan, and Peer Mohammed; Tamil filmmakers Lenin Bharati and Gopi Nayinar, and Sivakumar of LVP film institute; Publishers Prof 'Sirpi' Balasubramanian, P.R. Rajan, B. Bhaskar; and science communicators S. Harish, Dr Michael Noel, A. Hemavathy, Dr Ganesh Velusamy, and Ganesh Loganathan.

During the concluding event that set the pace for Ariviyal Palagai's journey into the future, Dr G. Rajasekaran of the Institute of Mathematical Sciences (IMSc) spoke about the undaunted spirit of eminent scientists, and Dr R Ramanujam of IMSc spoke about what needs to be done, as a society in Tamil Nadu to further the cause of science

Dr Nakul Parashar, director of Vigyan Prasar revealed Ariviyal Palagai's ambitious plans to propagate science in Tamil Nadu. He invited authors to contribute books, as Ariviyal Palagai targets to publish 20 original and 20 translated books in its first year. On 26 December, Ariviyal Palagai will conduct a state-wide solar eclipse awareness programme. Dr Parashar also announced that a web portal for Ariviyal Palagai would soon be up, with the able contribution and support of Tamil science communicators and volunteers. In the coming years, Ariviyal Palagai aims at conducting workshops on science writing and science filmmaking to create a fresh wave of science writers and science filmmakers in Tamil. ■