



**Science of Chocolate**  
Researchers from New York University have decoded the science behind the best tasting chocolate. The study, published in *Proceedings of the National Academy of Sciences*, pointed out that a process known as conching gives chocolate its silky smooth texture. Conching involves mixing ingredients for several hours which breaks the ingredients into smaller grains, reduces friction and provides the great taste. The study was done by researchers from the University of Edinburgh.



**In deep trouble**  
A study pushed into *Geophysical Research Letters* has pointed out that radioactive carbon from nuclear bomb testing has been detected in tissues of crustaceans living in deep ocean trenches, including the Mariana Trench. The level of Carbon-14 in the atmosphere doubled after the tests and many organisms consumed this carbon. Now scientists have shown evidence for increased levels of C-14 in marine organisms after the bomb tests began in 1950s.

## NBRI: Arsenic bioremediation using two soil bacteria

The bacteria increase bioavailability of metals, facilitate plant growth

ASWATHI PACHA

Using two indigenous strains of bacterium isolated from arsenic-contaminated field, researchers from CSIR-National Botanical Research Institute (CSIR-NBRI), Lucknow and the University of Lucknow have shown that arsenic can be effectively removed from contaminated soil with the help of microbes.

What adds value to these strains (*Bacillus flexus* and *Acinetobacter junii*) is the fact that they can promote plant growth too.

### Different forms of arsenic

Several studies have pointed out that using arsenic-contaminated water for agricultural purposes can lead to increased concentration of arsenic in fruits and grains, proving toxic to humans.

The researchers studied the two bacteria under different concentrations of arsenate and arsenite, the toxic forms of heavy metal. Arsenic treatment did not stunt or delay the growth of both the bacterial strains.

# Kolkata researchers use novel compound to kill cancer cells

The synthesised derivatives have better efficacy in killing cancer cells

R. PRASAD

Researchers at Kolkata's the Indian Institute of Chemical Biology (CSIR-IICB) and the Indian Association for the Cultivation of Science (IACS) have designed and synthesised about 25 quinoline derivatives that show potent anticancer activity. The compounds were tested *in vitro* against human Topoisomerase 1 (topo1) activity and their efficacy to kill cancer cells was carried out using breast, ovarian, cervical and colon cancer cell lines. The results of topo1 inhibition activity, cellular mechanisms and the cancer cell line studies carried out at IACS and the compounds designed and synthesised by IICB researchers were published in the *Journal of Medicinal Chemistry*.

"Preliminary data based on cell line studies suggest that the compounds from IICB might be effective against breast and colon cancer," says Srijita Paul Chowdhuri from the School of Biological Sciences at IACS and one of the first authors of the paper.

"The success of the project is due to the years immaculate design by going back-and-forth with our hypothesis through computational analysis followed by synthesis and X-ray crystallography even before the biological validation began," says Biswajit Kundu from the Medicinal Chemistry Laboratory at IICB and one of the first authors of the paper.

### Essential enzyme

Topoisomerase 1 is a fundamental enzyme that is essential for replication. DNA is in a supercoiled state and has to be unwound before replication can take place. For the DNA to uncoil, the topo1 enzyme has to first bind to



**Holds promise:** The compound might be effective against breast and colon cancer," say Srijita Chowdhuri (left) and Biswajit Kundu ■SPECIAL ARRANGEMENT

the DNA and form a complex. Once the complex is formed, the topo1 enzyme cleaves one strand of the DNA thus allowing the DNA to uncoil. Once uncoiling is completed, the topo1 enzyme rejoins the cleaved DNA strand for replication to take place.

Existing drugs and the quinoline derivatives synthesised by the IICB team have the ability to trap the complex thereby not freeing the topo1 to rejoin the cleaved DNA strand. As the number of trapped complexes in the DNA increases, the amount of free topo1 enzyme available to repair the cleaved DNA strand reduces. Also,

other enzymes involved in replication and transcription (where DNA is converted into RNA) come and collide with the trapped topo1 and this causes more DNA breaks. As a result, replication gets affected leading to DNA break and cancer cell death.

The mode of action of the existing drugs and the synthesised compounds is the same. The difference lies in the time the complexes remain trapped when the drugs or the synthesised compounds are used and therefore the ability to kill cancer cells.

Compared with normal cells, topo1 enzyme is produced in far excess

amount in cancer cells and so more complexes are formed. As a result, though topo1 enzyme is found even in normal cells, there is greater likelihood of the drugs specifically targeting the cancer cells.

"The existing drugs bind to the complex and trap it only transiently. This is because the drugs can be easily removed by body fluids. So within about 20 minutes, all the DNA breaks are repaired," says Dr. Benu Brata Das from the School of Biological Sciences and DBT-Wellcome India Alliance fellow at IACS and one of the corresponding authors of the paper. "So the existing drugs have less ability to kill cancer cells."

### Stable complex

"The existing drugs are not metabolically stable and so become inactive very fast. So using the existing drugs, the complexes can be trapped only for a brief period," says Dr. Arindam Talukdar from IICB and the other corresponding author. "But our compound can trap the complex for as long as five hours. All the 25 quinoline derivatives we synthesised show similar efficacy towards human topo1 inhibition." The ability of the synthesised derivatives to trap the complex for a much longer time might translate into better efficacy in killing cancer cells.

"The speciality of our compound is that they do not react with or bind to topo1 or the DNA when they are in isolation. They bind only when topo1 and the DNA form a complex. Thus, our designed compounds can be seen as targeted therapies," says Dr. Talukdar.

IICB jointly with IACS has already filed a patent in India for all the 25 quinoline derivatives.

## CCMB scientists sequence Asiatic lion genome

Y. MALLIKARJUN

For the first time, the entire genome of Asiatic lion, an endangered species, has been sequenced by scientists from CSIR-Centre for Cellular and Molecular Biology, Hyderabad.

De novo sequencing and annotation have resulted in a draft assembly of the entire genome of a male Asiatic lion. "This firsthand information would help us to better understand the evolution of Asiatic lions and also make possible comparative analysis with other big cats," says Dr. Ajay Gaur, the lead author of the study, which was recently published online in *BioRxiv*, the pre-print website.

### Comparative study

With the complete genome of royal Bengal tiger, African Cheetah and Jaguar available, comparative studies of all these big cats would be possible. He said only partial genomic information of the African lion was available now. Comparative genomics between African and Asiatic lions could be



undertaken once the complete genome of the African lion is sequenced.

The population of the endangered Asiatic lion is very low – only 523 animals are present in the Gir forests. The genome sequencing would enable scientists to develop specific markers to study population genetics (the differences at the gene level within a population) and get newer insights into its population status and subsequent management.

Comparative analysis with other felids and mammalian genomes unravelled the evolutionary history of the Asiatic lion and its position among other felids. The study noted that the evaluation of genetic diversity placed the Asiatic lion in the lowest bracket of

genomic diversity index highlighting the gravity of its conservation status.

The genome is estimated to be 2.3 Gb (Gigabase) long and is found to have 20,543 protein-coding genes.

### Multi-pronged approach

Dr. Gaur says that they found several candidate genes which are up-regulated in Asiatic lion and a few of them were specific to males.

As regards the crucial aspect of conservation of Asiatic lions, he says there is a need to adopt a multi-pronged approach and the study will enable better disease and population management of the endangered big cat by identifying characteristics which are specific to Asiatic lions.

CCMB Director, Dr. Rakesh Mishra says candidate genes which are specific to Asiatic lion can be identified by comparing with other big cats. The final objective is to understand the species at DNA level and study if there are any specific problems with regard to adaptability to environment or behaviour vis-à-vis other big cats.

## A global deal for postponing pralaya



**SPEAKING OF SCIENCE**

D. BALASUBRAMANIAN

The Earth and the atmosphere surrounding it receive radiation from the Sun, and get "heated". Some of the gases in the atmosphere, notably carbon dioxide (CO2) absorb this heat radiating from the earth's surface and bounce it back. This is what keeps the earth- land and seas- at a temperature range "comfortable" for us humans and the other organisms inhabiting the earth today. We thus live in a large "green house".

What happens when the level of these greenhouse gases increases? The temperature will rise. And this rise has been due to increases in the levels of CO2 and other gases, produced upon burning carbon-rich fuels (coal, wood, petroleum products). Over the last 100 years alone, the global temperature has risen by close to 2 degree. And if we do not reduce or stop these fuels and use alternate sources of energy (solar, wind and others), the global temperature will rise further.

### Two degree rise has been dangerous

We already see it in the form of the melting of ice caps and glaciers, causing a rise in sea level. This can submerge small island countries such as Maldives and Mauritius. It has also led to a change in the global climate, causing erratic monsoons, cyclones, tsunamis, El Nino and so on, affecting life on earth and in the oceans (fish, algae, coral reefs).

Temperature rise and climate change affect not just some countries but the entire globe, on which all species live- humans, animals, plants, fish, microbes. And if it is left uncontrolled, disaster looms for all life across the globe. Climate change, plus relentless industrial farming and fishing are leading to the extinction of 1 million species from Mother Earth within decades.

### Paris Agreement 2015

It is for acting against this catastrophe that the UNO brought countries across the world get together and in 2015 came up with what is called the Paris Agreement 2015 wherein they decided to make all efforts contain the temperature rise to no more than 1.5 degrees. While 195 countries across the globe signed the Paris Agreement and promised to take steps towards it, some oil producing/ importing countries such as Turkey, Syria, Iran and USA have not. President Trump says climate change is "fake"!

We need to do two urgent things. One is to reduce, indeed replace carbon-based fuels, with other forms of energy generation that do not generate greenhouse gases; hence solar power, wind power and others. The second is to enhance all natural methods which absorb CO2. Forests and plants do this best. Photosynthesis is done by all varieties of plants- algae in water, mangroves on the coast, crops and forests on land. They absorb atmospheric CO2 and produce oxygen for us to breathe. Tropical forests do this best; hence, deforestation in the Amazon, tropical Africa and in India must end. These regions also house over 200 million species of plants, animals and fungi. They are thus termed as Key Biodiversity Areas (KBAs); likewise are Marine Protection Areas (MPAs). They restore and protect biodiversity, increase yields and enhance ecosystem protection and defense. They alone help us preserve over 17% of land realm and 10% of marine areas by 2020, and preserve millions of species from extinction. But we need to do more beyond next year.

### Global Deal for Nature

It is with all this in mind that a diverse group of scientists and ecologists from across the world have come up with a companion pact to the Paris Agreement, called: "A Global Deal for Nature: Guiding Principles, Milestones and Targets". This policy document is published on 19 April 2019 in the journal *Science Advances*, which should be read by every concerned citizen and government. Global Deal for Nature (or GDN) has five fundamental goals: (1) representation of all native ecosystem types and stages across their natural range of variation; (2) maintain viable populations of all native species in natural pattern of abundance and distribution - or "saving species"; (3) maintain ecological functions and ecosystem services; (4) maximize carbon sequestration by natural ecosystems and (5) address environmental change to maintain evolutionary processes and adapt to the impact of climate change.

These five goals of GDN have three Priority themes. Theme 1 is on protecting biodiversity. Towards this, they have listed a total of 846 ecoregions across the world and given milestones on how to protect as much as 30% of them by the year 2030. Theme 2 is on mitigating climate changes by conserving carbon storehouses or climate stabilization areas (CSAs) and Other Effective area-based Conservation Measures (OECMs). These involve saving about 18% of existing areas across the world (e.g., tundra, rainforest) as CSAs and about 37% of the areas as OECMs (indigenous peoples' lands, such as in the Amazon Basin, Congo Basin, North-east Asia, Continental India). Theme 3 is on reducing threats to ecosystems, and concerns reducing major threats (such as overfishing, wild life trade, laying new roads cutting across forest lands, and building major dams).

### Yes, we can afford it!

And in order to do all this, the gross cost is estimated to be \$ 100 billion per year. Considering that these are over 200 nations across the world (plus the private sector, which too should also be involved), this is a sum well worth achievable if we are to leave the world livable for our children, and all the flora and fauna that have enriched our earth since the last 550 million years. And if one wishes count the pennies gained for this investment, Barbiers et al. point out that biodiversity conservation can actually offer \$ 50 billion annual profit for the sea food industry and save the insurance industry \$52 billion annually through reducing flood damage losses!

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## Obesity rising faster in rural areas

PTI

Obesity is increasing more rapidly in the world's rural areas than in cities, according to a study of global trends in BMI.

The study, published in the *Nature*, analysed the height and weight data of over 112 million adults across urban and rural areas of 200 countries.

The study found that from 1985 to 2017, BMI rose by an average of 2 kg/m2 in women and 2.2 kg/m2 in men globally, equivalent to each person becoming five to six kg heavier.

"The results of this study overturn commonly held perceptions that more people living in cities is the main cause of the global rise in obesity," said Professor Majid Ezzati of Imperial's School of Public Health. "This means that we need to rethink how we tackle this global health problem."

## Fast neutrino oscillations may hold key to supernovae formation

The oscillation is proportional to the density of neutrinos and not their masses

SHUBASHREE DESIKAN

Neutrinos could be the driving force behind supernova explosions, a new theoretical study from Tata Institute of Fundamental Research finds. The study which makes a fundamental advance in modelling neutrinos inside stars puts forth the idea that "fast neutrino oscillations" could hold the key to why some stars explode forming supernovae at the end of their lives.

Neutrinos come in three flavours: electron neutrino, muon neutrino and tau neutrino, so named because of the corresponding leptons they are associated with (electron, muon and tau). There are several puzzles they have posed, including how they are reordered according to mass and this puzzle still remains to be solved.

Earlier when measuring the number of neutrinos coming from the sun, experimentalists found that only a third of the number of solar neutrinos that was expected was being intercepted on earth. This was later explained by the understanding that they have a small mass and they can change from one flavour to another - a phenomenon named neutrino oscillations.

Fast neutrino oscillations are another phenomenon - When the same neutrinos are in the presence of many other neutrinos and when the different flavours are emitted slightly differently in various directions (anisotropy) the oscillations from one flavour to another happen at a higher frequency. This is called fast oscillation and is proportional to the density of neutrinos in the medium, and not the



**Massive explosion:** A NASA Hubble Space Telescope composite image shows star cluster NGC 2060 ■ REUTERS

masses of the neutrinos.

"Any star that collapses under its own gravity after having run out of its fusion fuel is called a supernova. Usually stars more massive than eight times the Sun's mass enter this phase of explosive death," explains Basudeb Das-

gupta of Tata Institute of Fundamental Research, Mumbai, one of the authors of the paper published in *Physical Review Letters*, in an email to *The Hindu*.

He further explains that this has not been observed as it requires a large neutrino