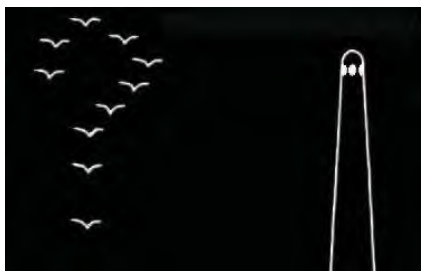
Dim lights, bright future

INTERNATIONAL DARK SKY WEEK IS BEING CELEBRATED TILL 26 APRIL. **S ANANTHANARAYANAN** EXPLAINS WHY

We all know that star-gazing, when we are in a large city, is not as rewarding as from the open countryside. The reason is that the glare of streetlights and other illumination in cities gets scattered back by the atmosphere, which is often polluted, and this interferes with the dim light from the stars. The stars then do not appear so bright and the fainter ones are not seen at all. International Dark Sky Week, which coincides with other international events like Earth Day and Astronomy Day, draws attention to the problems associated with *light pollution* and promotes simple solutions.

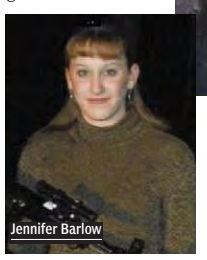
Dark Sky Week was created in 2003 by 15-year-old high school student Jennifer Barlow of Midlothian, Virgina, in response to a suggestion that a night be set apart for lights to be dimmed to help people enjoy the night sky. In explaining why she pushed for the week, Barlow said, "I want people to be able to see the wonder of the night sky without the effects of light pollution. The universe is our view into our past and our vision into the future… I want to help preserve its wonder."

In the open countryside, away from the city glare, there is less scattered background illumination and the night sky looks darker and the stars brighter. This is the reason that large telescopes and observatories are located at remote places, well away from city lighting. As images of the heavens are also obscured by the scattering of starlight by the atmosphere, telescopes are often located on mountain tops so that there is less atmosphere between the telescope and the stars being viewed. But in all cases, the telescope needs to be away from the glare of city lights.



Migrating birds are confused by lights.

The presence of background illumination not only obscures faint images but also affects the sensitivity of the eyes to detect feeble signals. When scientist CV Raman and his associates were engaged in spotting the very faint scattered and modified light that forms the Raman Effect, the experimenters' eyes had to be at their most sensitive. To make sure, they were confined in a darkened chamber for a full hour before they started their observation. Raman did his work on the Raman Effect in the Indian Association for the Cultivation of Science laboratory in Kolkata. The darkened chamber for sensitising eyes had, thus, been named the *Black hole of Kolkata* (this is a reference to the unfortunate event in the history of India, where British civilians perished in a dungeon in Fort William, Kolkata, in 1756).



Jennifer Barlow

In a review article in *Nature* in 1999, astronomer Malcolm Smith had noted that it was not only for better star gazing that it was important to keep the night time illumination levels down. He reviewed the findings of different researchers, that reduction of nighttime darkness has economic, environmental, cultural and medical effects. And according to the *I*nternational Dark-Sky Association, which promotes Dark Sky Week worldwide, the long-term effect of light pollution will do much more than burn a hole in our pockets.

Economics

A major consumer of energy is the lighting industry. Unplanned illumination results in astronomical costs in electricity and light fittings. A study by the International Dark Sky Association, based on satellite data from the dark side of the earth, finds that much of the world's lighting cost is in generating light that is not actually used but is beamed into outer space. Better designed lighting arrangements could result in huge economies, with no loss in the useful lumens. This is apart from avoiding the losses due to dangerous glare, traffic hazards and other damage caused by incorrect lighting. And then there are the economies possible by eliminating needless lighting, like in passages when nobody is there, or in many places till somebody is there.

Night sky over Lake Tekapo, New Zealand.

While humans appear to have adapted to light at all times of the day and night, animal populations are generally adversely affected. Migrating birds, for instance, suffer severe discomfort, and many lose their lives because of the confusion caused by brightly lit skyscrapers in their flight path. Some states have regulated the lighting of buildings during the season of bird migration and some of them have realised that the regulation could as well continue after the birds have flown past!

Many of us may be aware that animals in forests and reserves are thrown into confusion during a solar eclipse, when the light level drops during the day. The effect of increasing illumination during the night is found to be equally drastic, with human colonisation in animal habitats drawing first blood by nighttime lighting alone, quite apart from the destruction of foraging areas, natural habitat, etc.

Unesco

A sad reality of our times is that children in cities have often never seen common animals like monkeys or squirrels, and know of them only through picture books. But more serious is the fact that many of them have never seen the night sky in its glory. A good number of city dwellers have not seen the Milky Way, our own galaxy, the depth of whose disk paints the night sky with a swathe that has given it its name. And the glare of city lights often hides from sight many constellations and important stars that form a part of our scientific and cultural heritage.

The International Astronomical Union has signed an agreement with Unesco to the effect that an unobstructed view of astronomical formations is a world heritage that deserves protection as much as historical sites and natural history. The Lake Tekapo and Aoraki Mount Cook sites in New Zealand that are renowned for the clarity and brilliance of their night skies have been declared *Starlight Reserves* (like a wildlife reserve). "It really is a wonderful night sky here and there are very few places left in the world now where you can get that view," Professor Phil Butler, head of physics and astronomy at the University of Canterbury, has said. Many countries are beginning to understand that clear night skies have scope for eco-tourism. We are aware of the lure of the wildlife and the green cover of forests in much of India, but it is now being understood that the night skies in much of rural India are also worth protecting and exploiting!

Physiology

While it appears that people are adapted to artificial lighting and distorted diurnal routines, what toll these conditions actually levy has not been researched. There are some findings to show that exposure to light during night hours can suppress the production of melatonin, a hormone that controls many body cycles according to the rhythm of night and day. Following a disturbed cycle may be tolerated for its benefits in work and the pleasures of the high life, but its effect in the long term may be far ranging. Melatonin, for instance, acts as a suppressant of cell division in cancerous cells. Disturbed exposure to light may still not be projected as a factor in cancer, but continued denial of periods of darkness cannot be assumed to be without adverse effects on health.

THE WRITER CAN BE CONTACTED AT simplescience@gmail.com

ORGANISM DEVELOPMENT

TAPAN KUMAR MAITRA EXPLAINS HOW AND WHY CYTOKINESIS DIVIDES THE CYTOPLASM

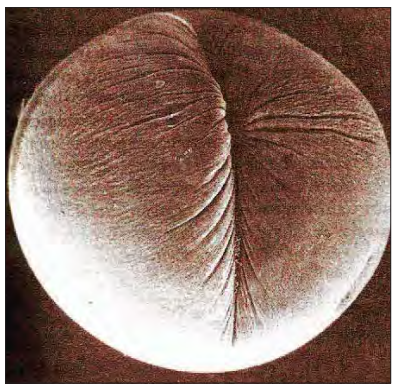
After the two sets of chromosomes have separated during anaphase, cytokinesis divides the cytoplasm in two, thereby completing the process of cell division. Cytokinesis usually starts during late anaphase or early telophase, as the nuclear envelope and nucleoli are reforming and the chromosomes are decondensing. Cytokinesis is not inextricably linked to mitosis, however. In some cases, a significant time lag may occur between nuclear division (mitosis) and cytokinesis, indicating that the two processes are not tightly coupled. Moreover, some cell types can undergo many rounds of chromosome replication and nuclear division in the absence of cytokinesis, thereby producing large multinucleated cells.

In some cases, the multinucleate condition is permanent while in other situations the multinucleate state is only a temporary phase in the organism's development. This is the case, for example, in the development of a plant seed tissue called *endosperm* in cereal grains. Here, nuclear division occurs for a time unaccompanied by cytokinesis, generating many nuclei in a common cytoplasm. Successive rounds of cytokinesis then occur without mitosis, walling off the many nuclei into separate endosperm cells. A similar process occurs in developing insect eggs. The fertilised egg undergoes mitosis but not cytokinesis, and it soon consists of hundreds of nuclei in the same cytoplasm; later, cytokinesis catches up.

Despite these examples, in most cases cytokinesis does accompany or closely follow mitosis, thereby ensuring that each of the daughter nuclei acquires its own cytoplasm and becomes a separate cell. The mechanism of cytokinesis is quite different in animals and plants. In animal cells, cytoplasmic division is called cleavage. The process begins as a slight indentation or puckering of the cell surface, which deepens into a cleavage furrow that encircles the cell, for a fertilised frog egg. The furrow continues to deepen until opposite surfaces make contact and the cell is split in two. The cleavage furrow divides the cell along a plane that passes through the central region of the spindle (the spindle equator), suggesting that the location of the spindle determines where the cytoplasm will be divided. This idea has been investigated experimentally by moving the mitotic spindle using either tiny glass needles or gravitational forces generated by centrifugation.

If the experimenter moves the spindle before the end of metaphase, the orientation of the cleavage plane changes so that it passes through the new location of the spindle equator. However, if the spindle is not moved until metaphase has been completed, the cleavage plane then passes through the area originally occupied by the spindle equator. Hence, the site of cytoplasmic division must be programmed by the end of metaphase.

Cleavage depends on a beltlike bundle of actin microfilaments called the *contractile ring*, which forms just beneath the plasma membrane during early anaphase. Examination of the contractile ring with an electron microscope reveals large numbers of actin filaments oriented with their long axes parallel to the furrow. As cleavage progresses, this ring of microfilaments tightens around the cytoplasm, like a belt around the waist, eventually pinching the cell in two. Tightening of the contractile ring involves interactions between actin microfilaments and the protein myosin (which interacts with actin to produce muscle contraction). During cleavage, the contractile ring behaves as a dynamic structure in which the polymerisation and depolymerisation of actin, accompanied by interactions between actin and myosin, drive closure of the ring.



Cytokinesis in an animal cell: An electron micrograph of a fertilised frog egg caught in the act of dividing. The cleavage furrow is clearly visible as an inward constriction of the plasma membrane. Within the cell, mitosis is nearly complete, so the cleavage furrow will separate the two sets of chromosomes as it continues to constrict the membrane.

The contractile ring provides a dramatic example of the rapidity with which actin-myosin complexes can be assembled and disassembled in non-muscle cells. Polymerisation of actin monomers into microfilaments takes place just before initial indentation of the cleavage furrow, and the entire structure is dismantled again shortly after cytokinesis is complete. The actin monomers used in assembling the microfilaments of the contractile ring are obtained by disassembly of the actin filaments of the cytoskeleton, just as the tubulin needed for spindle microtubules is derived from cytoskeletal microtubules.

Cytokinesis in higher plants differs in a fundamental way from the corresponding process in animal cells. Because plants cells are surrounded by a rigid cell wall, they cannot create a contractile ring at the cell surface that pinches the cell in two. Instead, they divide by assembling a plasma membrane and a cell wall between the two daughter nuclei. In other words, rather than pinching the cytoplasm in half with a contractile ring that moves from the outside of the cell toward the interior, the plant cell cytoplasm is divided by a process that begins in the cell interior and works toward the periphery.

Cytokinesis in plants is typically initiated during late anaphase or early telophase, when a group of small membranous vesicles derived from the Golgi complex align themselves across the equatorial region of the spindle. These vesicles, which contain polysaccharides and glycoproteins required for cell wall formation, are guided to the spindle equator by the *phragmoplast*, a parallel array of microtubules derived from polar microtubules and oriented perpendicular to the direction in which the new cell wall is being formed. After they arrive at the equator, the Golgi-derived vesicles fuse to produce a large flattened sac, called the *cell plate*, which represents the cell wall in the process of formation.

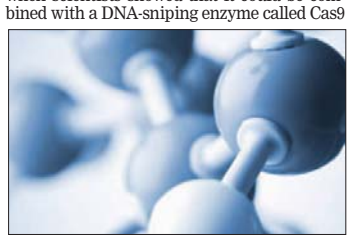
THE WRITER IS ASSOCIATE PROFESSOR, HEAD, DEPARTMENT OF BOTANY, ANANDA MOHAN COLLEGE, KOLKATA, AND ALSO FELLOW, BOTANICAL SOCIETY OF BENGAL, AND CAN BE CONTACTED AT tapanmaitra59@yahoo.co.in

'Editing' DNA to heal

STEVE CONNOR REPORTS ON THE 'FANTASTIC ADVANCE' OF A NEW TECHNIQUE THAT CAN ALTER LIFE-THREATENING MUTATIONS WITH PINPOINT ACCURACY

A genetic disease has been cured in living adult animals for the first time using a revolutionary genome-editing technique that can make the smallest changes to the vast database of the DNA molecule with pinpoint accuracy. Scientists have used the genome-editing technology to cure laboratory mice of an inherited liver disease by correcting a single "letter" of the genetic alphabet that had been mutated in a vital gene involved in liver metabolism.

A similar mutation in the same gene causes the equivalent inherited liver disease in humans — and the successful repair of the genetic defect in laboratory mice raises hopes that the first clinical trials on patients could begin within a few years, scientists said. The success is the latest achievement in the field of genome editing. This has been transformed by the discovery of Crispr, a technology that allows scientists to make almost any DNA changes at precisely defined points on the chromosomes of animals or plants. Crispr — pronounced "crisper" — was initially discovered in 1987 as an immune defence used by bacteria against invading viruses. Its powerful genome-editing potential in higher animals, including humans, was only fully realised in 2012 and 2013 when scientists showed that it could be combined with a DNA-sniping enzyme called Cas9 and used to edit the human genome.



A genetic disease has been cured in living, adult animals for the first time using a revolutionary genome-editing technique.

Since then there has been an explosion of interest in the technology because it is such a simple method of changing the individual letters of the human genome — the three billion "base pairs" of the DNA molecule — with an accuracy equivalent to correcting a single misspelt word in a 23-volume encyclopaedia.

In the latest study, scientists at the Massachusetts Institute of Technology used Crispr to locate and correct the single mutated DNA base pair in a liver gene known as LAH, which can lead to a fatal build-up of the amino acid *tyrosine* in humans and has to be treated with drugs and a special diet.

The researchers effectively cured mice suffering from the disease by altering the genetic make-up of about a third of their liver cells using the Crispr technique, which was delivered by high-pressure intravenous injections.

"We basically showed you could use the Crispr system in an animal to cure a genetic disease, and the one we picked was a disease in the liver which is very similar to one found in humans," said Professor Daniel Anderson of MIT, who led the study. "The disease is caused by a single point mutation and we showed that the Crispr system can be delivered in an adult animal and result in a cure. We think it's an important proof of principle that this technology can be applied to animals to cure disease," he said. "The fundamental advantage is that you are repairing the defect, you are actually correcting the DNA itself. What is exciting about this approach is that we can actually correct a defective gene in a living adult animal."

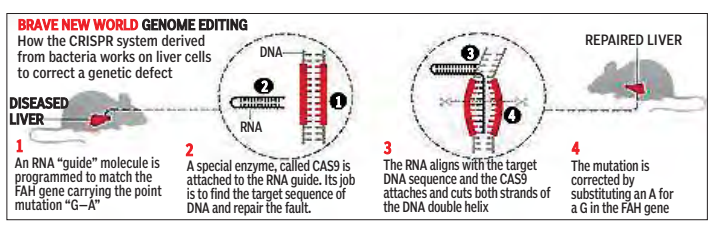
Jennifer Doudna of the University of California, Berkeley, who was one of the co-discoverers of the Crispr technique, said Professor Anderson's study was a "fantastic advance" because it demonstrated that it was possible to cure adult animals living with a genetic disorder. "Obviously there would be numerous hurdles before such an approach could be used in people, but the simplicity of the approach, and the fact that it worked, really are very exciting," she said. "I think there will be a lot of progress made in the coming one to two years in using this approach for therapeutics and other real-world applications."

Delivering Crispr safely and efficiently to affected human cells is seen as one of the biggest obstacles to its widespread use in medicine. Feng Zhang, of the Broad Institute at MIT, said that high-pressure injections were probably too dangerous to be used clinically, which is why he is working on ways of using Crispr to correct genetic faults in human patients with the help of adeno-associated viruses, which are known to be harmless. Other researchers are also working on viruses to carry the Crispr technology to diseased cells — similar viral delivery of genes has already had limited success in conventional gene therapy.

Dr Zhang said that Crispr could also be used to create better experimental models of human diseases by altering the genomes of experimental animals as well as human cells growing in the laboratory.

Professor Craig Mello of the University of Massachusetts Medical School said that delivering Crispr to the cells of the human brain and other vital organs would be difficult. "Crispr therapies will no doubt be limited for the foreseeable future," he said.

THE INDEPENDENT



PLUS POINTS

Miracle material

Graphene's reputation as a miracle material is well established, but scientists may just have added another attribute to the carbon-derivative's hit list: you can also make it using a kitchen blender. The discovery comes from a team of scientists from Trinity College in Dublin who wanted to industrialise the process that had originally led to graphene's discovery. First manufactured by a pair of chemists from Manchester University, the single atom-thick layers of carbon atoms were

famously isolated using the lo-fi method of peeling off sheets of the stuff from powdered graphite — the material found in pencil tips. To this end the Dublin team sought to speed up this shearing process by mixing together graphite powder, washing-up liquid and water and then blitzing it in a high-power blender for up to half an hour at a time. The resulting black goop contained large micrometre-sized flakes of graphene suspended in the water.

The team, led by Jonathan Coleman, stressed that determining exactly the right balance of detergent and graphene required the use of a lab-grade spectrometer and that subsequently separating out the material from the solution was even more difficult. The end product is not as high quality as that produced by labs growing the material out of vapour, atom by atom, but the process (already patented) could still be fantastically useful, with the resultant graphene flakes suited for an array of applications in everything from creating faster electronics to water bottles that use less plastic and have a longer shelf life.

"It is a significant step forward towards cheap and scalable mass production," Andrea Ferrari, an expert on graphene at the University of Cambridge, told *Nature*. "The material is of a quality close to the best in the literature, but with production rates apparently hundreds of times higher."

Currently the market for manufacturing graphene is booming as speculative investors throw money at various companies. However, a lot of the material produced is of low quality, with defects in the atomic structure or chemical containments reducing the material's efficacy. Early studies suggest that Coleman's process could be scaled up from the kitchen blender-size to an industrial, 10,000-litre vat that could produce as much as 100 grams of graphene per hour. Given that current rates of production do not exceed 0.4 grams per hour, this would be a significant step forward.

JAMES VINCENT/THE INDEPENDENT

Floating turbines

A new sort of inflatable wind turbine that floats thousands of feet above the ground could be a powerful source of sustainable, low cost energy say engineers. Altaeros Energies' Buoyant Airborne Turbine may look like a novelty bouncy castle, but when launched into the air it becomes a floating turbine, held in a strong, helium inflated chassis and soaring twice as high as traditional fixed turbines.

"The reason high altitude winds are so exciting and worth going after is really very simple: there's just a lot more of it," explains Ben Glass, CEO of Altaeros Energies, in a promotional video. "Winds 1,000-2,000 feet above the ground are on average five to eight times more powerful than what you get on the ground."

As the wind turns the turbines, the power is transmitted hundreds of metres down industrial strength cables to a base unit. These tethers can cope with high pressures and automatically raise and lower the turbine to exploit the fastest and most consistent winds.

"For decades, wind turbines have required cranes and huge towers to lift a

few hundred feet off the ground where winds can be slow and gusty," explains Glass. "We are excited to demonstrate that modern inflatable materials can lift wind turbines into more powerful winds almost everywhere — with a platform that is cost competitive and easy to set up from a shipping container."

Unlike traditional wind turbines, the Bat is not intended to provide power to major grids; instead it will offer a cheap alternative to traditional energy sources in remote parts of the world or in disaster relief scenarios. As well as turbines, the Bat can also hoist cellular equipment or meteorological devices into the air. This week it will face its first commercial test as it is tried out in a number of small Alaskan villages as an alternative to costly diesel generators.

JACK PITTS/THE INDEPENDENT