The Daily Star

SCIENCE & LIFE

DHAKA TUESDAY OCTOBER 26, 2010, E-MAIL: science&life@thedailystar.net

Energy revolution: Key to complex life

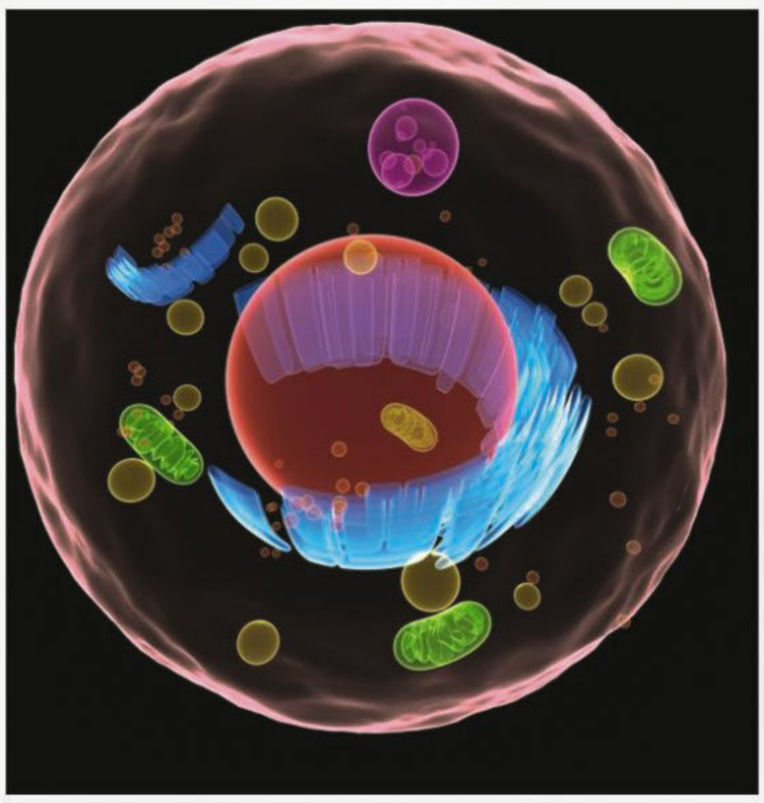
THE evolution of complex life is strictly dependent on mitochondria, the tiny power stations found in all complex cells, according to a new study by Dr Nick Lane, from UCL (University College London), and Dr William Martin, from the University of Dusseldorf.

"The underlying principles are universal. Energy is vital, even in the realm of evolutionary inventions," said Dr Lane, UCL Department of Genetics, Evolution and Environment. "Even aliens will need mitochondria."

For 70 years scientists have reasoned that evolution of nucleus was the key to complex life. Now, in work published in Nature, Lane and Martin reveal that in fact mitochondria were fundamental to the development of complex innovations like the nucleus because of their function as power stations in the cell.

"This overturns the traditional view that the jump to complex 'eukaryotic' cells simply required the right kinds of mutations. It actually required a kind of industrial revolution in terms of energy production," explained Dr Lane.

At the level of our cells, humans have far more in common with mushrooms, magnolias and marigolds than we do with bacteria. The reason is that complex cells like those of plants, animals and fungi have specialized compartments including an information centre, the nucleus, and power stations -- mitochondria. These compartmentalised cells are called 'eukaryotic', and they all share



Artist's rendering of basic cell structure, including mitochondria

a common ancestor that arose just once in four billion years of evolution.

Scientists now know that this common ancestor, 'the first eukaryote', was a lot more sophisticated than any known bacterium. It had thousands more genes and proteins than any bacterium, despite sharing other features, like the genetic code. But what enabled eukaryotes to accumulate all these extra genes and proteins? And why don't bacteria bother?

By focusing on the energy available per gene, Lane and Martin showed that an average eukaryotic cell can support an astonishing 200,000 times more genes than bacteria.

"This gives eukaryotes the genetic raw material that enables them to accumulate new genes, big gene families and regulatory systems on a scale that is totally unaffordable to bacteria," said Dr Lane. "It's the basis of complexity, even if it's not always used."

"Bacteria are at the bottom of a deep chasm in the energy landscape, and they never found a way out," explained Dr Martin. "Mitochondria give eukaryotes four or five orders of magnitude more energy per gene, and that enabled them to tunnel straight through the walls of the chasm."

The authors went on to address a second question: why can't bacteria just compartmentalise themselves to gain all the advantages of having mitochondria? They often made a start but never got very far.

The answer lies in the tiny mitochondrial genome. These genes are needed for cell respiration, and without them eukaryotic cells die. If cells get bigger and more energetic, they need more copies of these mitochondrial genes to stay alive.

Bacteria face exactly the same problem. They can deal with it by making thousands of copies of their entire genome -- as many as 600,000 copies in the case of giant bacterial cells like Epulopiscium, an extreme case that lives only in the unusual guts of surgeonfish. But all this DNA has a big energetic cost that cripples even giant bacteria -- stopping them from turning into more complex eukaryotes. "The only way out," said Dr Lane, "is if one cell somehow gets inside another one -- an endosymbiosis."

Cells compete among themselves. When living inside other cells they tend to cut corners, relying on their host cell wherever possible. Over evolutionary time, they lose unnecessary genes and become streamlined, ultimately leaving them with a tiny fraction of the genes they started out with: only the ones they really need.

The key to complexity is that these few remaining genes weigh almost nothing. Calculate the energy needed to support a normal bacterial genome in thousands of copies and the cost is prohibitive. Do it for the tiny mitochondrial genome and the cost is easily affordable, as shown in the Nature paper. The difference is the amount of DNA that could be supported in the nucleus, not as repetitive copies of the same old genes, but as the raw material for new evolution.

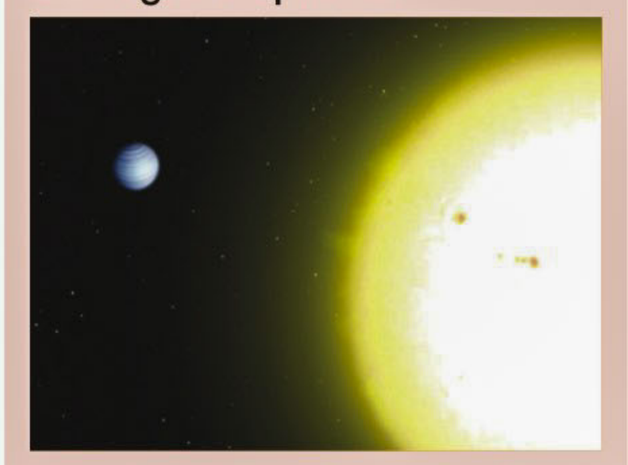
"If evolution works like a tinkerer, evolution with mitochondria works like a corps of engineers," said Dr Martin.

The trouble is that, while cells within cells are common in eukaryotes, which often engulf other cells, they're vanishingly rare in more rigid bacteria. And that, Lane and Martin conclude, may well explain why complex life -- eukaryotes -- only evolved once in all of Earth's history.

Source: Science Daily

SURPRISES GALORE

Strange exoplanet



Among the more than 400 planets found beyond our solar system, there are volcanic Super Earths, gas giants that dwarf Jupiter, and worlds with multiple sunsets

Many recent breakthroughs have occurred in planet detection. The frontiers being crossed are towards planets with wider orbits and less mass. Along the way, though, strange objects may require retuning theories, and maybe even definitions.

"We are in fantastic times," said Michel Mayor of the Observatoire de Geneve. "In ten years, we have a lot of new data."

Mayor was one of the astronomers who detected the first extrasolar planet - that is, outside our solar system - in 1995 around the star 51 Pegasi. To commemorate this and other discoveries the Space Telescope Science Institute (STScI) organized its May 2005 Symposium, "A Decade of Extrasolar Planets Around Normal Stars."

Planets had been found earlier, in 1993, around a pulsar, which is a magnetically active neutron star. Although pulsars do not create very habitable surroundings, not many of the other planets found since are likely to support life either - which some may find disappointing.

"At the end of the day, all these fine people - who are looking for planets and how they form -really are interested in this question: 'Is there intelligent life elsewhere?'" said Mario Livio of STScI.

Planet-hunters hope to give part of the answer by determining whether our solar system is common or unique. A lot of the new data paints a picture in which more planets are more likely to be found. Some day, almost certainly, astronomers will celebrate the tenth anniversary of the first Earth-like planet detected around a Sun-like star, many astronomers say.

Source: Live Science

OIL DOOGRES

Corals in oil spill zone

JUST 20 miles north of where BP's blown-out well spewed millions of gallons of oil into the sea, life appears bountiful despite initial fears that crude could have wiped out many of these delicate deepwater habitats.

Plankton, tiny suspended particles that form the base of the ocean's food web, float en masse 1,400 feet beneath the surface of the Gulf of Mexico, forming a snowy-like underwater scene as they move with the currents outside the windows of a two-man sub creeping a few feet off the seafloor.

Crabs, starfish and other deep sea creatures swarm small patches of corals, and tiny sea anemones sprout from the sand like miniature forests across a lunar-like landscape illuminated only by the lights of the sub, otherwise living in a deep, dark environment far from the sun's reach.

Scientists are currently in the early stages of studying what effects, if any, BP PLC's April 20 oil well blowout off Louisiana and the ensuing crude gusher has had on the delicate deep sea coral habitats of the northern Gulf.

So far, it appears the area dodged a bullet, but more research is needed. Some of the deep sea corals near the spill site were only discovered just last year.

"Originally, when we saw the trajectory for the oil spill and where it was going, we were very concerned that these habitats would be impacted," said researcher Steve Ross of the Center for Marine Science at the University of North Carolina at Wilmington.

Ross and others are conducting research from a Greenpeace ship in the Gulf, using a two-man sub as they work to determine if the corals have suffered damage, or may take a hit from long-term impacts, such as stunted reproduction rates.

Source: AP

A submersible carrying John Hocevar, Oceans campaign director for Greenpeace, and Associated Press reporter ...

ACTIVE MORNING STAR

Volcanism on Venus!

BENEATH its dreary shroud of clouds, Venus could be positively hopping: Planetary geologists have spotted a lava flow they say is just decades old. If confirmed, it would be the youngest evidence for volcanism on Venus.

"The flow we studied seems to be very young it is still warm inside," says Nataliya Bondarenko, a planetary scientist at the University of California, Santa Cruz. She and her colleagues describe their findings in an upcoming issue of Geophysical Research Letters.

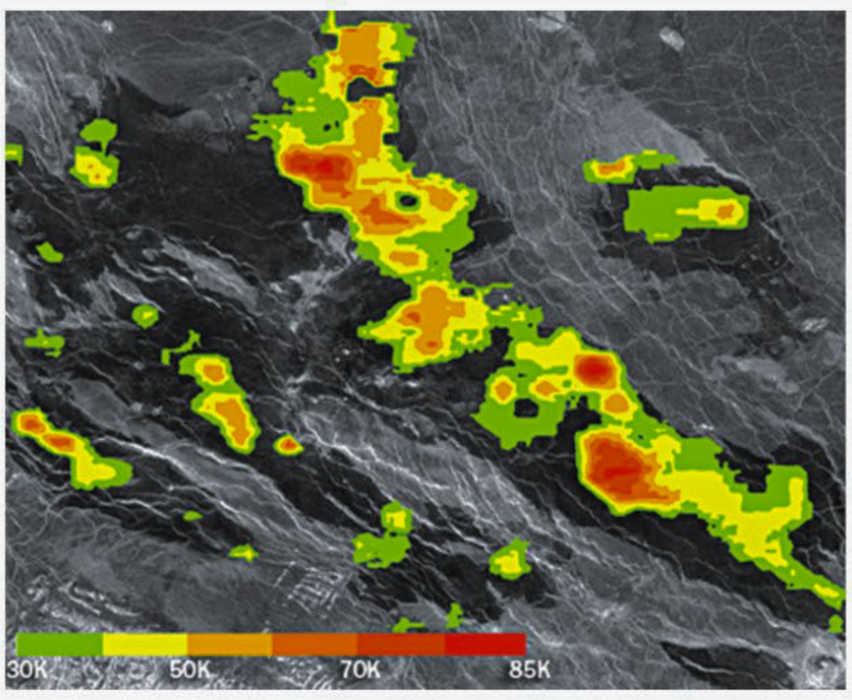
Researchers have long thought that Venus must be geologically active, since more than 1,000 volcanoes dot its surface. But scientists have struggled to gather definitive evidence that the planet is active today, like Earth, and not long dead, like Mars.

The new study builds on recent work suggesting that Venusian volcanoes are indeed a thing of the present.

Bondarenko's team analyzed microwave data collected by NASA's Magellan mission, which orbited Venus in the early 1990s. Microwave radiation indicates heat coming from the planet, such as a lava flow in the process of cooling.

In the Bereghinia Planitia region in Venus' northern hemisphere, the team found a flow that appeared up to 85 degrees Celsius hotter than expected. Had the flow been more than a century old, Bondarenko says, it would have cooled down enough that Magellan wouldn't have spotted any excess heat.

The flow must have been at least 15 years old when detected by Magellan, she says, because the Pioneer Venus orbiter photographed it in 1978.



As seen in microwave wavelengths, a lava flow in Venus' northern hemisphere shows hot spots (red) up to 85 degrees Celsius warmer than expected

But there's little other evidence supporting Bereghinia Planitia as recently volcanically active, says Suzanne Smrekar, a planetary geologist at the Jet Propulsion Laboratory in Pasadena, Calif.

In April, Smrekar and colleagues published a paper in Science describing lava flows from three regions in Venus' southern hemisphere. All three were places known to be hot spots of geological activity, similar to Hawaii. Using data from the European Space Agency's Venus Express mission, currently orbiting the second planet, Smrekar's team found several flows that looked fresh. The flows' unweathered appearance, compared with the surrounding landscape, suggests that they formed no more than 2.5 million years ago and probably in the past 250,000 years, the team concluded.

Because the Venus Express data come only from the southern hemisphere, they can't say anything about whether Bereghinia Planitia is also active, Smrekar says. But any claim of a decades-old flow in the north "sort of falls into the 'extraordinary claims require extraordinary proof' category," she says.

For their part, Bondarenko and her colleagues want to expand their research to look for other fresh flows on Venus.

Source: Science News.

BLACK BOX MYSTERY

X PRIZE

To spur brain research

GETTING paralyzed patients to walk or demonstrating virtual telepathy between humans and computers are possible future challenges for researchers, experts said during a brain symposium held here last week.

But receiving the funding to unlock the secrets of the human brain may prove equally daunting during a time of slow economic recovery, experts said. During the symposium hosted by Brown University on Oct. 13, representatives of a venture capital firm, a nonprofit foundation and a medical device company discussed how to forge ahead with neurotechnology.

"The current economy is focused on conserving resources, not investing in risk-taking," said Daniel O'Connell, a founding member and partner in NeuroVentures Capital.

Prize money could encourage companies to take the plunge despite the risks, according to Eileen Bartholomew, senior director of prize development at the X Prize Foundation. Winning such prizes would need clear goals, such as allowing paralyzed patients to "pick up a glass of water, or step out of a wheelchair," she added.

Brain disorders currently affect more than 100 million Americans and are responsible for more costs than any other area of health care, O'Connell said. He added that total costs of care for people with Alzheimer's disease alone are likely to skyrocket from $172 billion in 2010 to more than $1 trillion in 2050 that is, if nothing is done to help prevent or cure the disease.

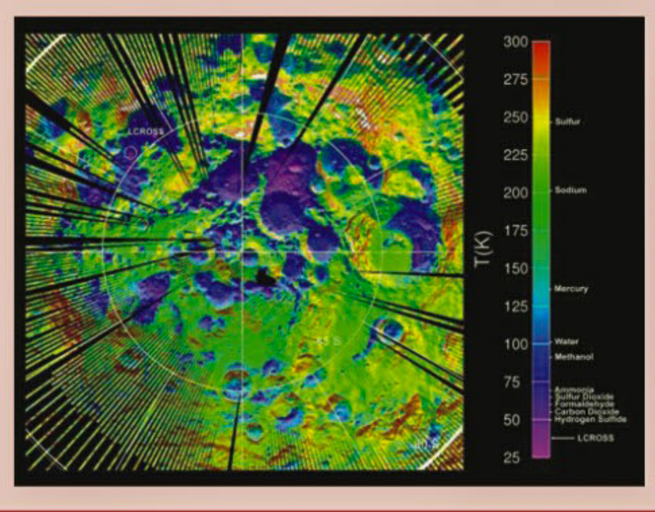
But pharmaceutical companies tend to focus on "what's easy and profitable" despite an interest in developing new drugs for brain disorders, O'Connell explained. And venture capitalists that might pony up private funding for new devices or therapies are also moving cautiously.

Source: Live Science

MOON'S COLD TRAPS

Lunar 'Permafrost'

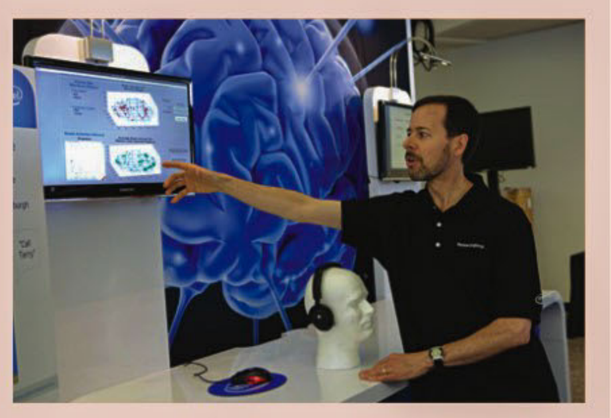
LRO surface temperature map of the moon's south polar region. LRO Diviner Lunar Radiometer Experiment surface temperature map of the south polar region of the moon. Data were acquired during September and October 2009, when south polar temperatures were close to their annual maximum values. The map shows the locations of several intensely cold impact craters that are potential cold traps for water ice, as well as a range of other icy compounds commonly observed in comets. The approximate maximum temperatures at which these compounds would be frozen in place for more than a billion years is shown next to the scale on the right



OID YOU KNOW?

All Earth's gold

Gold is virtually indestructible; almost all the gold ever mined still exists today... all 165 000 tonnes (182 000 tons) of it, only enough gold to fill two Olympic-sized swimming pools. All it would neatly fit under the Eiffel Tower. That is not a lot. That is because you'll have to drill through 250 tonnes of rock, then pulverize it, then chemically treat it to get enough gold for only a single wedding ring. Gold also simply is beautiful to look at for reasons not always understood. These the beauty and the scarcity are the qualities that has always made gold one of the most sought-after precious metals with the price of an ounce trading for $1000



In a joint project with Carnegie Mellon University and the University of Pittsburgh, Intel Labs shows that thought-based user interfaces are not as far-fetched as one might think