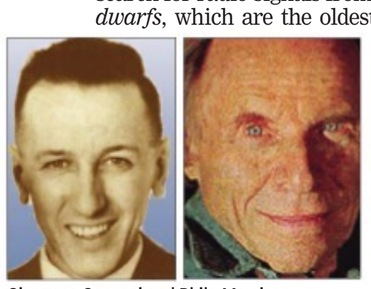
Looking for little green men

A NEW PATH HAS BEEN MARKED OUT IN THE QUEST FOR EXTRA-TERRESTRIAL INTELLIGENCE, WRITES **S ANANTHANARAYANAN**


Is anybody out there?

The question of whether there is life in the universe has become more real with the growth in our means of accessing outer space. Spectroscopic analyses of light or other radiation from distant worlds, analyses of meteorite material and, more recently, material brought back by space missions all include the search for traces of biological activity. And then the search for signals of any kind from possible advanced civilisations in the cosmos.

The Search for Extra-Terrestrial Intelligence Institute, a California-based organisation that has been coordinating these efforts, has just set in motion a two-year programme of a concerted search for radio signals from a set of 20,000 *red dwarfs*, which are the oldest stars in the universe, as a project directed at an area of the greatest promise. Red dwarfs are considered promising both because they are older and also because the "sun-like" stars that we have been looking at so far are generally further away than many red dwarfs.


Giuseppe Cocconi and Philp Morrison

While evidence of life forms detected in extra-terrestrial samples or in the spectra of light from deep space would be exciting, the only way we could become aware of intelligent life forms seems to be that we detect apparently well coded radio signals. The principles of what kind of signals to look for were first discussed by Giuseppe Cocconi and Philp Morrison in a classic paper in the journal *Nature* in 1959. They reasoned that if there were signals sent out by sentient beings in space, these would need to be low frequency waves that are the least dispersed and could last long distances. Within this range, the suitable frequencies per second would be above one megacycle but below 30 megacycles, which is the frequency at which the gases in the atmosphere are strongly absorbent. Higher frequency radio signals, in any case, are not easy to detect. And within this permitted range, the band from one megacycle to 10 megacycles per second was considered the best.

But for all this, scanning for a signal at an unknown frequency within a band and making it out against the background emissions from the planet and its star would be challenging. Cocconi and Morrison, hence, suggested that an intelligent civilisation may select a specific frequency that pertained to hydrogen, the most prevalent element in the universe — the characteristic radio emission line of hydrogen, at 1,420 megacycles per second, or a wavelength of 21 cm, as a standard. Looking for this radiation, with allowance for spread, some 300 kilocycles per second, due to the motion of the emitter, was, hence, recommended as the way to go. But even for this specific signal, there was considerable "noise" or radiation from other hydrogen sources that would render a weak signal difficult to make out. The level of such disturbance was the most, about 40 per cent stronger, along the plane of the Milky Way galaxy in which the Solar System is located. It was, hence, recommended that the direction to look was towards the nearest stars that lay off the galactic plane.

The next question was of the kind of signals to look for. Cocconi and Morrison worked it out that the signal would be in pulses, maybe some one second apart, and as it would be decades at least before a signal was detected the train of pulses may continue for a period of years before it was repeated.


Proxima Centauri, the closest star at 4.2 light years, is a red dwarf.

Earth-like planets

While different Seti programmes have been in action since then, with new technology there has also been the quest for "earth-like" planets of distant solar systems. We have looked for such planets because it is accepted that life, at least as we understand it, may not exist outside the narrow temperature belt in which water and a large number of carbon-based organic substances are in the liquid state. Silicon-based life is conceivable but the temperature may be too high for many chemical processes or intra and inter-cellular communication to be possible for sustaining life. The quest has, hence, been of distant planets that are close enough, but not too close, to their parent stars.

There has also been a restriction of the kind of stars that may host earth-like planets. If the stars are too bright, things may be too warm for earth-like conditions and then, if the star is too cool, the planet would need to be in a very near orbit to receive sufficient heat. This second case of the star being too cool, no doubt, does not rule out fair conditions and there are a great many of these cooler stars, the so-called "red dwarfs". But it has been considered, first, that there may not be many planets in the narrow zone very near the parent star and, second, that at this near orbit the planet would get "tidally locked" and not rotate on its axis, like planets in general, but only once per revolution around the star. If this is the case, the star-facing side of the planet would get unbearably hot despite the star being cool, and the opposite side, which would face empty space, would be far below the freezing point of most substances. The quest has, therefore, been only of planets that orbit "sun-like" stars and a great number have now been found.

Recent research has shown, however, that if near-orbit planets of red dwarfs had oceans and an atmosphere, heat would move from the hot side to the cold and there would be areas that could support life. The discovery of exoplanets in the last decades has also shown that near-orbit planets of red dwarfs are quite frequent. These discoveries point in the direction of red dwarfs being good prospects as the home of earth-like planets and, hence, of intelligent life. Red dwarfs are also there in good numbers. "Significantly three-fourths of all stars are red dwarfs," says Seth Shostak, of the Seti Institute. As there are so many more red dwarfs, it would be possible to find a good number of them much nearer than sun-like stars, he says.

Greatest antiquity

Red dwarfs are smaller, of low mass and, hence, slower burning stars that "simmer", so to speak, while larger stars blaze. In smaller stars, the helium that is produced by nuclear fusion of hydrogen atoms at the core spreads to other parts and does not accumulate at the core. These stars, hence, continue burning their hydrogen content over a long period. Red dwarfs that formed soon after the beginning of the universe, over 10 billion years ago, would, hence, still be there, which makes them the oldest, apart from the most numerous stars there are.

The Seti Institute at Mountain View, California, sees these discoveries — both that planets in near-orbit around red dwarfs can be earth-like and that such planets are there in good numbers, and also the fact that it is here that life has had the most time to arise — as good reasons to turn telescopes towards red dwarfs in the quest for extra-terrestrial radio signals. A list of 20,000 red dwarfs is being drawn up out of a list of 70,000 that has been compiled and also other data about nearby stars, including red dwarfs.

"We'll scrutinise targeted systems over several frequency bands between one and 10 GHz," says institute scientist Gerry Harp. "Roughly half of those bands will be at so-called 'magic frequencies' — places on the radio dial that are directly related to basic mathematical constants. It's reasonable to speculate that extraterrestrials trying to attract attention might generate signals at such special frequencies."

As Cocconi and Morrison said, "The probability of success is difficult to estimate, but if we never search the chance of success is zero."

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Dangers of ET encounters

THE celebrated Stephen Hawking, while participating in the launch of initiatives to search for intelligent life in the cosmos, has cautioned that being found by such a civilisation may not be the best thing for the earth. Advanced aliens may have the capability to wipe out the human race and there is no reason for us to believe that they would show more compassion that what humans have shown, time and again, to creatures or peoples less capable than themselves, says Hawking.

Other studies have also compared contact with a technologically superior civilisation with similar contact of greatly different human civilisations. The contact of Europe with the Americas, after Christopher Columbus, resulted in the transfer of people, ideas, animals, plants, microbes and disease to the great advantage of the Europeans and the effective elimination of the original Americans.

ET inititiatives, thus, limit themselves to detecting alien signals and not actively advertising the earth. But there are also contests, worldwide, seeking ideas for the best messages to include in broadcasts or "time capsules" sent into space. The only possible contact, as of now, may only be the decoding of a radio message, and actual visits by aliens or alien spacecraft are not seriously considered.

INDEFINITE REPRODUCTION

CANCER CELLS, SAYS **TAPAN KUMAR MAITRA**, ARE IMMORTALISED BY MECHANISMS THAT MAINTAIN TELEMERE LENGTH

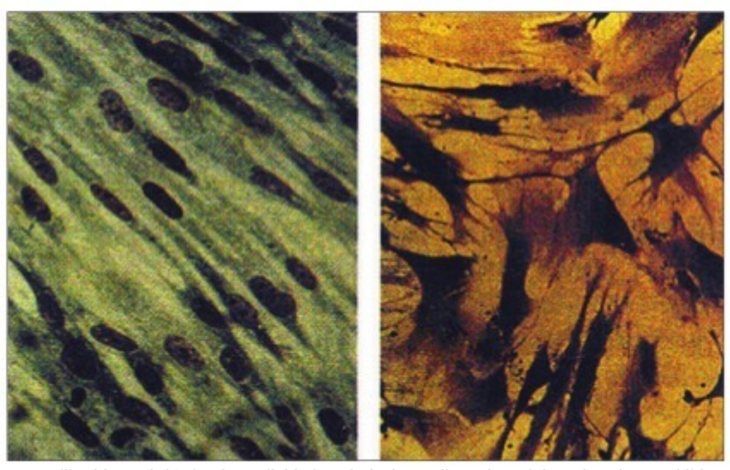
When normal cells are grown in culture, they usually divide a limited number of times. For example, human fibroblasts — a cell type whose behaviour has been extensively studied — divide about 50-60 times when placed in culture, then they stop, undergo a variety of degenerative changes and may even die. Under similar conditions, cancer cells exhibit no such limit and continue dividing indefinitely, behaving as if they were immortal. A striking example is provided by *HeLa* cells, which were obtained in 1953 from a uterine cancer diagnosed in a woman named Henrietta Lacks (hence the term "HeLa"). After the tumor was removed by surgeons, some of its cells were placed in culture and these quickly began to proliferate and have continued to do so for more than 50 years, dividing more than 18,000 times with no signs of stopping.

Why do cancer cells reproduce indefinitely in culture, whereas most normal human cells divide no more than 50-60 times? The answer is related to the telomeric DNA sequences that are lost from the ends of each chromosome during every round of DNA replication. If a normal cell divides too many times, its telomeres become too short to protect the ends of the chromosomes and a pathway is triggered that halts division (and may even destroy the cell by apoptosis). This prevents any excessive, uncontrolled proliferation of adult cells and helps to explain why normal fibroblasts divide only 50-60 times in culture.

In cancer cell populations, the telomere-imposed limit is overcome by mechanisms that replenish the disappearing telomere sequences. Most cancer cells accomplish this feat by producing *telomerase*, the enzyme that adds telomeric DNA sequences to the ends of DNA molecules. An alternative mechanism for maintaining telomere length employs enzymes that exchange DNA sequence information between chromosomes. By one mechanism or the other, cancer cells maintain telomere length above a critical threshold and thereby retain the capacity to divide indefinitely.

Eukaryotes have solved the end-replication problem by locating highly repeated DNA sequences at the terminal ends, or telomeres, of each linear chromosome. These special telomeric elements consist of short repeating sequences enriched in the base G in the 5' ® 3' strand. The TTAGGG sequence, located at the ends of human chromosomes, is an example. Human telomeres typically contain between 100-1,500 copies of the TTAGGG sequence repeated in tandem. Such non-coding sequences at the ends of each chromosome ensure that the cell will not lose any important genetic information if a DNA molecule is shortened slightly during the process of DNA replication.

Moreover, a special DNA polymerase called telomerase can catalyse the formation of additional copies of the telomeric repeat sequence, thereby compensating for the gradual shortening that occurs at both ends of the chromosome during DNA replication.


Young fibroblasts (left) that have divided a relatively small number of times in culture exhibit a thin, elongated shape. After dividing (right) about 50 times in culture, the cells stop and undergo a variety of degenerative changes. Note the striking difference in appearance between the young (dividing) and older (non-dividing) cells.

Telomerase is an unusual enzyme in that it is composed of RNA as well as protein. In the protozoan *Tetrahymena,* whose telomerase was the first to be isolated, the RNA component contains the sequence 3'-AACCCC-5', which is complementary to the 5'-TTGGGG-3' repeat sequence that makes up *Tetrahymena* telomeres. This enzyme-bound RNA serves as a template for creating the DNA repeat sequence that is added to the ends of the telomeres.

After they have been lengthened, telomeres are protected by *telomere capping proteins* that bind to the exposed 3' end of the DNA. In addition, in many eukaryotes the 3' end can loop back and base-pair with the opposite DNA strand, generating a closed loop that likewise protects the end of the telomere.

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Just like salamanders

NEW STEM CELL THERAPY RAISES HOPES OF NEW REGENERATIVE TREATMENTS. **JOHN VON RADOWITZ** REPORTS

A new kind of stem cell raises the prospect of regenerative treatments that mimic the way salamanders grow new limbs, according to Australian researchers. Therapies based on "induced Multipotent Stem" cells could be tested in human trials as early as next year, they say.

The team, from the University of New South Wales, demonstrated a way of producing iMS cells by reprogramming bone and fat cells. In theory, the cells could be used to repair bone, cartilage, and muscle. Unlike other kinds of stem cells that can differentiate into many types of tissue, iMS cells are not thought to run the risk of triggering cancer.


The cells could repair bone, cartilage and muscle.

Lead scientist Professor John Pimanda said, "We are currently assessing whether adult human fat cells reprogrammed into iMS cells can safely repair damaged tissue in mice, with human trials expected to begin in late 2017. This technique is ground-breaking."

To date researchers investigating regenerative treatments have experimented with Embryonic Stem cells and Induced Pluripotent Stem cells. Both behave in a similar way, multiplying indefinitely and having the ability to transform into any kind of body tissue. While ES cells are natural, obtained from early-stage embryos, iPS cells are made by reprogramming adult cells. But both run the risk of generating cancerous tumours, and iPS cells are created using genes injected by viruses, which is clinically unacceptable.

The iMS cells which are the focus of the new research reported in the journal *Proceedings of the National Academy of Sciences* have a more limited capacity but are claimed to be safer than ES or iPS cells. The Australian team produced them by inducing "plasticity" in bone and fat cells from mouse and human donors.

The technique involved exposing the cells to a compound called AZA as well as a platelet-derived "growth factor" — a substance that stimulates growth. It mimics the remarkable way salamanders use plasticity to regenerate lost limbs or tails, according to the scientists.

Dr Ralph Mobbs, also from the University of New South Wales and who will lead the human trials, said, "The therapy has enormous potential for treating back and neck pain, spinal disc injury, joint and muscle degeneration and could also speed up recovery following complex surgeries where bones and joints need to integrate with the body."

In another breakthrough, scientists at the Sanford-Burnham Medical Research Institute in San Diego, California, believe baldness may soon be a thing of the past because stem cells could hail a new future in the way the condition is treated. The most common form of alopecia, or hair loss, is male-pattern baldness, which affects around 50 per cent of men by the time they reach 50. Female-pattern baldness is less common, and less understood, but usually hits when a woman goes through menopause. While alopecia is not life-threatening in itself, social pressures mean that those who suffer from the condition can feel self-conscious, and can become depressed.

In the past, scientists isolated health dermal papilla cells, which are vital to hair growth, and grew these in a culture. But as the cells reproduce, they become less effective. To make their breakthrough, the San Diego team avoided the problem by producing the papillae from stem cells — a technique proven to work on rats. Alexey Terskikh, an associate professor at Sanford-Burnham, said he hoped the procedure could lead to more effective hair transplants in humans. "Our stem cell method provides an unlimited source of cells from the patient for transplantation and isn't limited by the availability of existing hair follicles," he said.

THE INDEPENDENT

PLUS POINTS

Water power

What if humidity can be used to power your smartphones or iPads? With new findings that water droplets can generate small amounts of electricity, this appears possible in the near future. Researchers at the Massachusetts Institute of Technology have discovered that when water droplets spontaneously jump away from superhydrophobic surfaces during condensation, they can gain an electric charge in the process.

Apart from charging electronic devices, the new system could also produce clean water. The device will have a series of interleaved flat metal plates that can be made of cheaper aluminium. "

"As water droplets jump, they carry charge from one plate to the other; if the two plates are connected through an external circuit, that charge difference can be harnessed to provide power," said post-doctoral fellow Nenad Miljkovic and Evelyn Wang, an associate professor of mechanical engineering, at MIT. The system is based on their earlier findings that droplets on a superhydrophobic surface convert surface energy to kinetic energy as they merge to form larger droplets. This sometimes causes the droplets to spontaneously jump away, enhancing heat transfer by 30 per cent relative to other techniques.

"The atmosphere is a huge source of power and all you need is a temperature difference between the air and the device," Miljkovic said. This will allow the device to produce condensation, just as water condenses from warm, humid air on the outside of a cold glass, he said in a paper published in the journal *Applied Physics Letters*.

IANS

Megacity menace

Crowded conditions in developing world megacities can dramatically increase the effect of climate on infectious diseases, according to a study published in the Proceedings of the National Academy of Sciences on 28 March.

The study, based on 22 years of rotavirus cases in Dhaka, Bangladesh, found infection rates during the monsoon were around 10 times higher in the densely populated centre than the quieter periphery. The virus is the most common cause of diarrhoea in children worldwide and is responsible for more than 400,000 deaths a year.

Rotavirus infection rates in tropical countries are fairly consistent throughout the year with a slight peak in cool seasons, although some studies have found evidence of spikes when river levels are high. But the study found that a higher baseline of rotavirus infection in the congested core of Dhaka, the city of 15 million, appeared to make it far more sensitive to flood-driven outbreaks than the suburbs — resulting in a regular second peak during the warm monsoon months.

"As we get more-populated megacities, we have to be aware this is going to have strong epidemiological consequences, including in terms of responses to climate," said co-author Mercedes Pascual, an ecologist at the University of Chicago in the USA.

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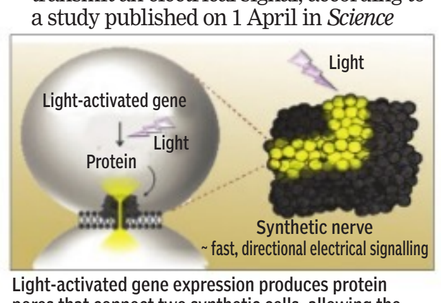
Synthetic tissue

Researchers at the University of Oxford, UK, have engineered a soft, tissue-like material, built from hundreds of DNA-containing synthetic cells that can transmit an electrical signal, according to a study published on 1 April in *Science Advances*. The expression of genes in each "cell" — a 3-D-printed water droplet surrounded by a single layer of lipids — is light-activated, giving the researchers precise control over the behaviour of the material.



Light-activated gene expression produces protein pores that connect two synthetic cells, allowing the passage of ions (left). When printed in a 3-D tissue-like material, the cells transmit an electrical signal under illumination (right).

"It's really beautiful work," said Sheref Mansy, a biochemist who builds cells from scratch at the University of Trento, Italy, and was not involved in the research. "It's fantastic to be able to show the ability to arrange these synthetic cells so precisely, with communication between the different droplets."

Each lipid-encased droplet has a volume of 50-100 picolitres and contains the simplest set of genes needed to make a transmembrane pore protein — a channel through which small molecules can pass — that spans the lipid bilayer formed between adjacent droplets. Synthesis of this protein is regulated by a light-activated DNA promoter, meaning that pores are only produced (and, therefore, electrical signals are only transmitted) when a droplet has been illuminated.

THE SCIENTIST