Looking for signs of life

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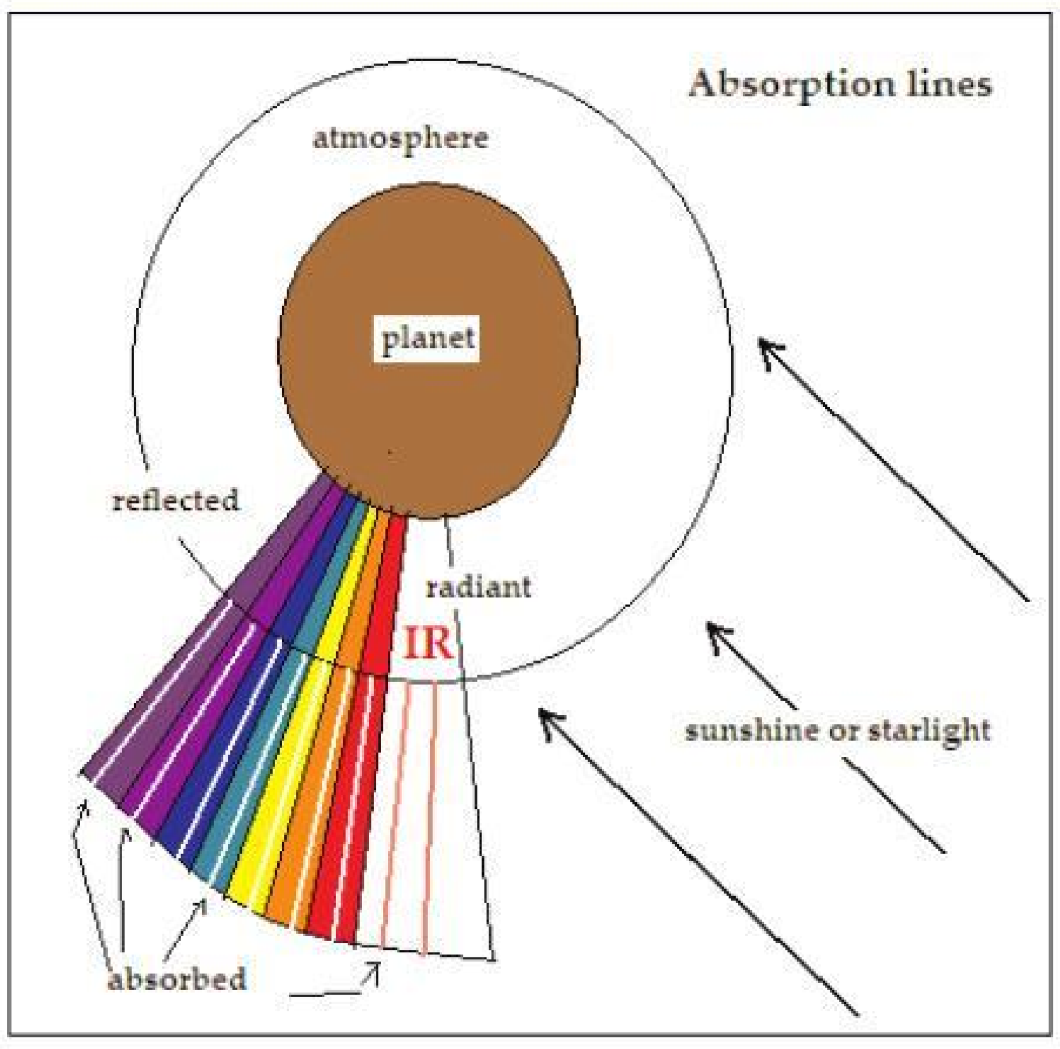
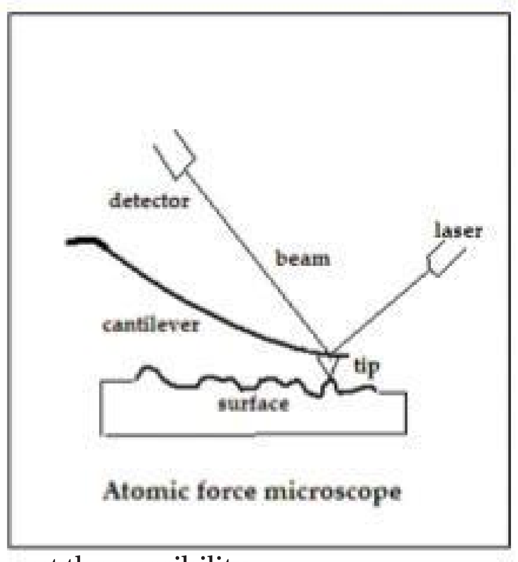
There is much interest in the search for evidence of life outside Earth. While one way is to analyse samples brought back from outer space, a more promising method is through studies by probes that are landed on distant worlds.

The indicators of life, which we look for, are based on the chemicals that are associated with life as we know it on Earth. Hence, we use known methods to test for life on far-off planets. But we could be misled if the chemicals associated with other forms of life are not the same as those on Earth.

Some years ago, an alternate method to detect life without relying on chemicals was proposed. It was based on the fact that living things do not stay unchanged, or at one place, but they grow or move. Giovanni Dietler, Sandor Kasas and Giovanni Longo, with Simone Ruggeri FS, Benadiba C, Maillard C, Stupar P and Tournuc H, at Ecole Polytechnique Fédérale de Lausanne, Switzerland, in the journal, *Proceedings of the National Academy of Sciences*, suggested a method using a micrometre scale seesaw, to detect microscopic physical movement as an indicator of growth or locomotion. One immediate application could be to assess the efficacy of drugs in the pharmaceutical lab. But it could be equally effective in detecting life at an extra-terrestrial place!

Researchers in Switzerland have suggested a method to detect microscopic physical movement that would indicate growth or locomotion





Chemicals of life

Life, as we know it, is associated with carbon dioxide, methane, water and ozone. Finding all of them, or even most of them, on a planet in the Solar System, or even elsewhere in space, would be taken as a first-rate indicator of life. Our space probes have arrangements to analyse the soil and atmosphere when they get to planets.

Even on Earth, we can look for signs of chemicals on distant planets by analysing the spectrum of the light that has passed through the planet's atmosphere while it is reflected to Earth. Or, we could study the spectrum of infra-red light, or heat, that the planet radiates. As particular chemicals in the atmosphere absorb specific frequencies of light, or IR waves, we can make out the chemicals that were there, by the frequencies that seem to be reduced in the spectrum of the light that comes to us.

The mix of the four signature chemicals on Earth has changed over the ages, as life evolved from single-celled creatures to plants, dinosaurs, birds and mammals. Finding signature chemicals on a planet would hence indicate both a strong possibility of life, as well as possibly, the state of evolution.

These methods of detecting life would work, of course, for life of the kind that we know of on Earth. But there could be other forms of life, which would not lead to the build-up of just these or all these chemicals. While life on Earth is carbon based, there could, in principle, be organic-type molecules based on silicon too. Not that it is likely, as silicon-based life would need to exist at high temperature, and metabolic processes would need to be different, if at all possible.

But there could be other chemical bases for self-replicating organisms that resemble life. And then, even if the life forms were similar to those on Earth, there may be different processes in the circulation of by-products, which would not leave signature chemicals in the atmosphere. Looking at all this, although finding the right chemicals on a planet would be a strong indicator of life, not finding them would not rule out the possibility.

One more indicator of life that is considered is an indirect one -- the creation of a smooth and undulating topography in a planet that supports life, as opposed to a jagged and rocky one in a planet that does not. Studies of soil erosion and movement of landmasses on Earth have shown that while rivers, rainfall, freezing of water and winds do cause the breakup of rocks to smaller fragments, the chief cause of creating loose, transportable soil, which moderates discontinuities in the landscape, are biotic or biologically driven processes, like animals burrowing, growth of roots and microbial action. Such effects also tend to synchronise with seasonal temperature variations and maintain the topography.

But for all this, topography alone cannot assure biotic origin, as other processes are also capable of creating smooth and soil-covered terrain. In the Atacama Desert of Chile, there is a hyper-arid region called the central depression, where biotic processes are simply not supported. But salt weathering does break down bedrock and the rock surfaces receive inputs of wind-blown soil sediment. And the landscape is rounded and covered with soil!

Detecting movement

The Lausanne scientists adapted the existing atomic force microscope to sense motion at the scale of the activity of bacteria, to act as a detector of direct and non-chemical signs of life. The idea is that if there is something living in there, then it is going to move, either move some limb or carry out a biological process, of feeding, excretion or growth.

The atomic force microscope is a tiny protrusion, just micrometres in dimensions, that swings free from a holder. The protrusion is thus a lever fixed at one end, or a cantilever. At the free end there is a tip, of the order of nanometres (a millionth of a millimetre), which protrudes down to scan the surface being examined. Unevenness of the surface causes the lever to move up or down, and the movement is detected by a laser beam that reflects off the lever. The arrangement can sense undulations at fractions of a nanometre.

In the adaptation by the Lausanne group, the cantilever is moved not by forces on the tip, but by movement of bacteria that are deposited on the lever itself. In trials carried out, the dimensions allow for about 500 bacteria to perch on the lever. Movement of even a few of them affects the load on the lever and it swings up or down -- and is detected by the laser beam sensor. Over a period of time, the printout of the laser beam trace can reveal if there is movement going in the culture on the lever. "The system has proven accurate with detecting bacteria, yeast, and even cancer cells," a press release from EPFL says.

An immediate application of the arrangement would lie in the testing of drug preparations. An array of cantilevers could be covered with bacteria or cancer cells and different drug compounds could be tried out at the same time. Where the drugs are effective, there would be rapid decrease and then cessation of movement. It would be a fast and convenient method to test a range of candidate curative agents and speed up drug development.

The same arrangement could also be made part of the test equipment of landing crafts on planets or comets. "As it relies on motion rather than chemistry, the cantilever sensor would be able to detect life forms in mediums that are native to other planets, such as the methane in the lakes of Titan", said a press note that was issued.

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PLUS POINTS

Booster jabs

Two Covid-19 jabs don't offer strong protection against symptomatic infection from the new omicron variant, United Kingdom government analysis shows -- with the vaccines less effective than against delta. Those who have received a booster jab, however, remain up to 70 per cent protected.

The impact of the new variant is already being felt in the UK. Omicron is transmitting more effectively than delta and is expected to become dominant by next week, at which point it will account for more than 50 per cent of all infections, the U K Health Security Agency said. Current trends suggest Britain will have reached more than one million omicron cases before the end of December.

How it translates into pressure on the National Health Service remains unclear, but Dr Susan Hopkins, chief medical advisor for the UKHSA, said there was concern that "even very small reductions in vaccine effectiveness against severe disease can cause an increase admissions".

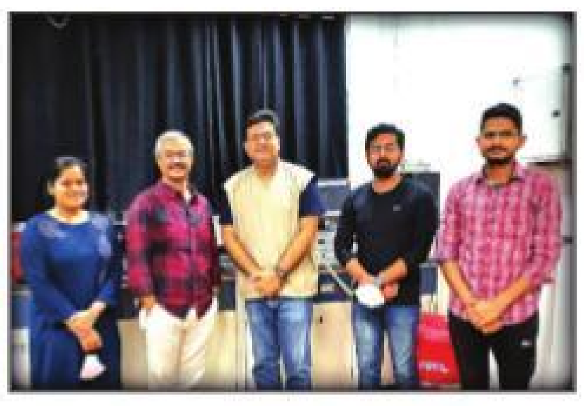
UKHSA analysis shows that the AstraZeneca and Pfizer vaccines provide much lower levels of protection against symptomatic infection from omicron than delta, making the double-jabbed vulnerable to the variant. Individuals who had received a Pfizer jab following two doses of either vaccine, however, were between 70 and 75 per cent protected, the research showed. Close to 40 per cent of all people aged over 12 in the U K have received a booster.

Vaccine effectiveness against severe disease from omicron is not yet known but is expected to be significantly higher than protection against mild infection, even after two doses. Data on this won't be available for several weeks, the UKHSA said.

The analysis was based on 581 people infected with omicron, alongside thousands of delta cases. UKHSA warned against over-interpreting the results.

The Independent

Promising research



A team of researchers from the Indian Institute of Science Education and Research-Bhopal, comprising members from the groups of Saptarshi Mukherjee, professor, department of chemistry, and Chandan Sahi, department of biological sciences, have developed a safe and easy procedure to produce silver nanomaterials that can be used as antimicrobial agents.

The details and results of the work have been published in the journal of the American Chemical Society, *ACS Applied Materials and Interfaces*. The paper has been authored by Subhajit Chakraborty, Preeti Sagarika, Saurabh Rai, Sahi and Mukherjee.

Antibiotic resistance is a serious condition in which bacteria and other microbes that invade the human body become resistant to the antibiotics/antimicrobials that are meant to kill them. This problem is serious for India, the "antimicrobial resistance capital of the world" due to rampant and indiscriminate use of antibiotics in humans, livestock, and agriculture.

Mukherjee said, "Silver, the common ornamental metal, when present as nano-sized particles -- one hundred thousand times smaller than the width of a single human hair -- have good antimicrobial properties."

The researchers used the amino acid tyrosine to produce nanomaterials of silver that had excellent antimicrobial properties. Tyrosine is present in many food items, including meat, dairy, nuts, and beans. They treated silver nitrate, the main component of the "election ink" used to stain nails after voting in India, with tyrosine in the presence of caustic soda. Tyrosine functioned as a reducing agent and capping agent to produce silver nanomaterials.

On examining the product under high-resolution microscopes, they found two forms of silver nanostructures -- nanoclusters and nanoparticles. The nanoparticles were found to kill microbes such as *S. cerevisiae* (associated with pneumonia, peritonitis, urinary tract infection etc.), *C. albicans* (oral and genital infections), *E. coli* (stomach infection), and *B. cereus* (stomach infection), in about four hours.

"As our product comprises two components, it can be utilised for multiple purposes -- from photophysical studies to applications in biological systems," Mukherjee said.

A VIRAL THREAT

Here's the lowdown on dengue and its associated issues

TAPAN KUMAR MAITRA

The viral nature of dengue fever was ascertained in 1907 by Percy Moreau Ashburn and Charles Franklin Craig. The virus measures from 30 nanometres to 40 nm, and after adaptation to the body of mice by successive intracerebral passages, it grows readily in a chicken embryo *in vitro*. The virus contains thermostable and thermolabile antigens. The latter causes a group complement-fixation reaction with the viruses of yellow fever and Japanese and West Nile encephalitis.

The virus persists for a period of five years at -70°C in a dried state and remains viable for two months in a patient's serum at room temperature. It dies very quickly on exposure to light and is non-resistant to heating. Weak bile dilutions inactivate it in five minutes whereas ultraviolet rays and a 0.05 per cent formalin solution destroy it.

The virus is poorly pathogenic for laboratory animals. Adapted strains cause paralysis and death in albino mice and virusaemia in guinea pigs. Infection of Macaca rhesus monkeys results in a mild form of the disease.

The virus possesses toxic activity. It affects the neurons in the cerebrum and spinal cord and causes degenerative changes in the cells of the liver, kidneys and heart. It produces haemorrhagic lesions in the endocardium, pericardium, gastric and intestinal mucosa, peritoneum, central nervous system, muscles and skin. Deep disorders are revealed in the small blood vessels (swelling of the endothelium, perivascular oedema, and infiltration by mononuclear cells).

The sources of infection are sick people. The virus appears in the patient's blood during the latter 24 hours of the incubation period and remains there for three or four days of the febrile period. Infection occurs through the bite of *Aedes aegypti*, *Aedes allopictus* and *Aedes scutellaris* mosquitoes. At a temperature of 22°C, the mosquito becomes capable of transmitting the virus in eight-12 days after a meal on the patient's blood. But at 16°C, the causative agent does not develop within the mosquito's body and it remains infective for a period of 174 days.

The incubation period in dengue fever varies in duration from 2.5 to 15 days, lasting five to eight days on average. Quite frequently, the disease has a sudden onset with chills, headache, severe pains in the joints, muscles and eyeballs and a high fever (39-41°C). Erythema may be observed in some patients and a remission occurs in one to four days. The temperature drops and the body becomes profusely covered with perspiration. This is followed by a second attack which is characterised by an elevation of temperature and the presence of the same symptoms as in the first attack. A maculo-papular or scarlatina-like eruption appears on the body, lasting not longer than three or four days. The duration of the disease is four or five days.

During epidemics, mild and severe forms of the disease are encoun-tered along with the typical form. They are marked by coma, delirium, convulsions, and mucopurulent diarrhoea. The mortality rate is low as the patient usually recovers and the disease leaves an immunity which lasts from two to six months.

Diagnosis rests on clinical, epidemiological and laboratory findings. The virus is isolated from the blood in the first days of the disease by intracerebral inoculation of mouse sucklings (not over three days of age), and the complement-fixation reaction and neutralisation tests are performed.

There is no specific therapy. Symptomatic remedies are used like large amounts of liquid are given to drink, a 10 per cent glucose solution is injected intravenously, and amidopyrine, acetylsalicylic acid, preparations of iron, and vitamins C, B1, and B2 are given.

Dengue fever occurs as an endemic disease in regions with a tropical and subtropical climate. Prophylaxis comprises isolation of patients, prevention of access of the vectors to them, extermination of mosquitoes, and protection from their bites. Quarantine measures are enforced to prevent the spread of infection to countries free from the disease, but measures of specific prophylaxis are still being elaborated.

The writer is associate professor and head, department of botany,