

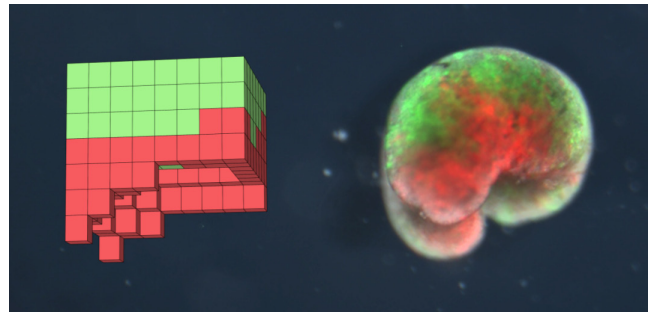
Xenobots: World's First Living, Self-healing Robots

RESearchers at the University of Vermont (UVM) and Tufts University, US, have created “Xenobot” – the world’s first living, self-healing robot from frog stem cells. These are tiny blobs of moving cells made from stem cells obtained from frog embryos. They are less than a millimetre in width facilitating them to travel inside the human body. Furthermore, they can walk and swim, can survive for weeks without food, and also work together in groups. Xenobots are named after the African clawed frog, *Xenopus laevis*.

Xenobots would prove useful for surgeries as they have holes that can be utilised to carry drugs or medicines to the body. They can perform other tasks too, like cleaning radioactive waste, collecting and degrading microplastic from the oceans. Xenobots can survive in an aqueous environment for several days or even weeks without nutrients.

The researchers took stem cells from the frog embryo and increased their numbers by incubating them. Next, the cells were cut and rejoined under a microscope into definite forms designed by artificial intelligence. These newly created forms are not found in nature. The skin cells bonded to develop a structure while the heart cells were able to work together and create motion. These cells also showed the ability to heal themselves after being cut.

According to a statement on the website of the University of Vermont (UVM), Joshua Bongard, a computer scientist and



robotics expert at the University of Vermont who co-led the new research says, “These are novel living machines. They’re neither a traditional robot nor a known species of animal. It’s a new class of artifact: a living, programmable organism.” The new creatures were designed on a supercomputer at UVM and then assembled and tested by biologists at Tufts University.

“We can imagine many useful applications of these living robots that other machines can’t do,” says co-leader Michael Levin who directs the Centre for Regenerative and Developmental Biology at Tufts, “like searching out nasty compounds or radioactive contamination, gathering microplastic in the oceans, travelling in arteries to scrape out plaque.”

The research was published in the *Proceedings of the National Academy of Sciences (PNAS)*.

Reference

Sam Kriegman, Douglas Blackiston, Michael Levin, and Josh Bongard. A scalable pipeline for designing reconfigurable organisms. *PNAS*, 2020 DOI: 10.1073/pnas.1910837117

Soft Materials Allow Scientists to Study Earthquakes in Lab

UNDER constant stress, certain soft materials reorganise themselves in a manner very similar to how the Earth’s crust is restructured during earthquakes, a new study by researchers at the Indian Institute of Science (IISc), Raman Research Institute (RRI) and ETH Zurich have found.

The team studied thin sheets of two types of soft materials — a tightly packed gel of soap-like molecules, and

a glass made from clay nanoparticles — sheared between two steel plates. When force was continuously applied by the plate on the material, the internal reorganization of the material generated burst-like patterns over time that resembled seismograph data generated by earthquakes.

“When you apply certain stress, the material is trying to adjust. Its shear rate is fluctuating. This fluctuation is similar to what is seen during earthquakes,” says Ajay Sood, DST Year of Science Chair Professor at the Department of Physics, IISc, and senior author of the paper published in *Nature Communications*.

Earthquakes typically occur due to friction between pieces of the Earth’s surface called tectonic plates, releasing a sudden burst of energy that causes severe damage to the environment and

human lives. Scientists still don’t know how to predict when an earthquake will strike next, or how strong it will be.

To simulate earthquakes in the lab, researchers usually apply force to rocks or ceramic materials and study how they deform and crack under stress. But because these are solids, it can be difficult to study changes that happen inside the materials before they split open.

“The main disadvantage with these previous experiments is that no one can probe the domain structure directly,” says Sayantan Majumdar, Associate Professor at RRI and one of the authors. “We cannot see what is going on inside the material.”

In the current study, the researchers used soft materials instead and observed how they reacted under stress. Using an optical microscope

Normal Body Temperature Declining

THE broad mark on the clinical thermometer indicates the average “normal” temperature of our body at 98.6° Fahrenheit. In fact, it varies from person to person depending upon sex, age and health status. Besides, it depends upon factors like time of the day (lowest in the morning, lower during the day and higher at night), the location of the body in which the measurement is taken (mouth, under the armpit, etc.), subject’s state of consciousness (waking, sleeping or sedated) and emotional state (anger, depression, etc.). Physical exercises, eating, drinking alcohol and smoking also affect it.

Usually, the average body temperature of kids is higher and also that of females is higher than males. Since it is sensitive to many hormones, during the menstrual cycles of women the basal body temperature rises sharply after ovulation as estrogen production decreases and progesterone increases. Taking all these factors into account the normal body temperature or normothermia has been stated as between 97.7° and 99.5° F beyond which the condition is called fever. This range is maintained by thermo-regulation, where lowering and rising of temperature is triggered by the Central Nervous System.

Called as “blood heat” in the 19th century the average normal body temperature was quoted as 98°F in most of the textbooks. But later, a large number of studies revealed it to be 98.6°F. Then in 1868, a German physician Carl Reinhold August Wunderlich set it in his book as the standard which was universally accepted for clinical use. However, since then the average human body temperature has been found to be declining steadily.

Researchers have arrived at the conclusion by studying three large databases – 23,710 readings recorded between 1862 and 1930, 15301 readings taken from 1971 to 1975 and 1,50,280 readings from 2007 to 2017. According to their observations, the body temperature of men born in the 2000s is on an average 1.06°F lower than that of the men born in 1800s. In the case of women, it is 0.58 °F.

The reason behind it has not yet been established conclusively. However, according to the scientists including Dr Julie Parsonnet, Professor of Medicine at the Stanford University and the lead author of a paper on the topic published in the January 2020 issue of the American journal *Wired*, our modern lifestyle, which has helped lower the resting metabolic rate, may be responsible for it.

Besides, today we are physiologically different from what we were in the past centuries. Our living environment, our contact with microorganisms, our food habits, etc. have greatly changed. May be these factors are somehow related to the decline of our average body temperature.

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and camera, they were able to look closely at how the inside of the material changed over time.

They found that the rate at which the material reorganised itself showed burst-like patterns persisting over thousands of seconds, resembling seismic foreshocks and aftershocks. These events usually happen over hundreds of kilometres during

earthquakes. “We were able to observe this phenomenon at about 10-micron scale length. That is a huge advantage,” says Pradip Bera, first author and a PhD student at the Department of Physics, IISc.

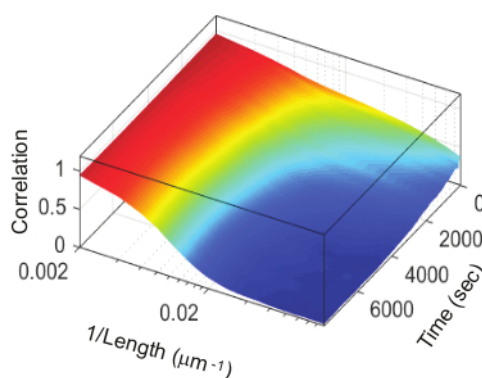
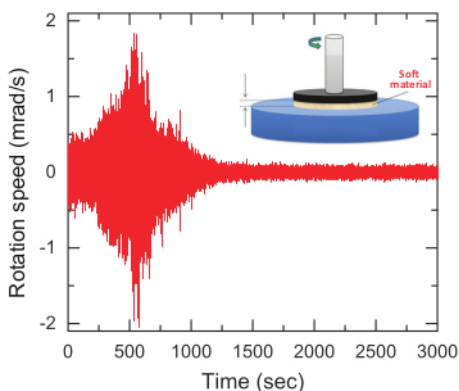
The researchers also found that these patterns obeyed laws that govern earthquake dynamics. One of these, called the Gutenberg-Richter law,

describes the strength of earthquakes. Another, called the Omori law, describes how the frequency of aftershocks reduces over time. Values for mathematical parameters defined by these laws, when calculated for the soft materials, were found to be very close to those that have been reported for real earthquakes. The time gaps between spikes were also found to closely match real-life patterns.

The researchers hope that further studies on such materials will eventually help identify microscopic precursors of earthquakes.

Reference

Quantitative earthquake-like statistical properties of the flow of soft materials below the yield stress, published in *Nature Communications*, January 2020. <https://www.nature.com/articles/s41467-019-13790-2>



Left: Measured angular speed of the top plate versus time. Inset shows the schematic of the experiment. Right: Time evolution of spatial correlation of domains, connecting burst-like event and internal reorganisations of the material (Credit: Pradip Bera *et al.*)

Halicin (top row) prevented the development of antibiotic-resistant bacteria *E. Coli*, while the antibiotic drug ciprofloxacin (bottom row) could not
Image Courtesy: Collins Lab, MIT (USA)

Drug Discovered by Artificial Intelligence

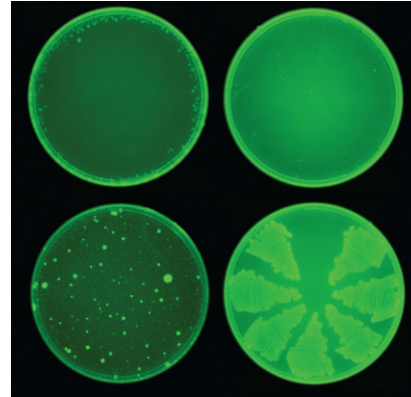
HALICIN, a new drug discovered using Artificial Intelligence (AI), has emerged as a promising antibiotic, effective against a broad range of resistant strains.

Antibiotic resistance among pathogens is a growing concern among scientists and laymen. Antibiotic resistance occurs when bacteria mutate and evolve to use alternative mechanisms and become resistant to antimicrobial drugs. With no new antibiotics to tackle this growing resistance, approximately 10 million lives around the world could be at risk each year from infections by 2050, according to a British study.

The new antibiotic *Halicin* was discovered by an artificial intelligence

system at Massachusetts Institute of Technology (MIT). A machine learning algorithm was used to identify molecules that are capable of killing bacteria. To achieve this, the machine was fed with atomic and molecular features of nearly 2,500 drugs and natural compounds against *E. coli*. Once this algorithm was learned by the machine, it was subjected to a working library of almost 6,000 compounds to identify the potential antibiotics.

Halicin kills some of the most dangerous strains of bacteria. Tests have proven that the drug wiped out dangerous strains including *Enterobacteriaceae* and *Acinetobacter baumannii*, which are high priority pathogens that the World Health Organization (WHO) ranks as critical for new antibiotics to target. Tests on bacteria collected from patients showed that *Halicin* killed *Mycobacterium tuberculosis*, the bug that causes TB, and strains of *Enterobacteriaceae* that



are resistant to carbapenems, a group of antibiotics that are considered the last resort for such infections. *Halicin* also cleared *C. difficile* and multidrug-resistant *Acinetobacter baumannii* infections in mice.

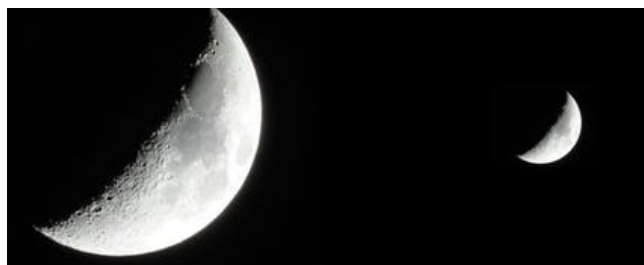
Jonathan Stokes, the first author of the research paper said that the process of identification by the machine took only a few hours. The scientists are now preparing for a study with a larger number of drugs.

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New Mini Moon of Earth

A new mini-moon was observed by researchers Kacper Wierzchos and Teddy Pruyne at the NASA-funded Catalina Sky Survey in Arizona on the night of February 15. It is about the size of a car roughly 6-11 feet in diameter. Researchers named it “2020 CD₃” – it is likely to be a carbonaceous type asteroid.

According to the astronomers, this finding is very important because the miniature moon is only the second asteroid known to orbit Earth after the 2006 RH120 which



was also discovered by the Catalina Sky Survey. 2006 RH120 rotated the planet from September 2006 to June 2007. It was suggested that 2020 CD₃ entered the Earth’s orbit around three years ago. In support of this “The Smithsonian Astrophysical Observatory’s Minor Planet Center” announces that no link was found for the known artificial object and it is likely the captured asteroid in the Earth’s gravity.

The researchers found that it has a rambling loop around the Earth about every four months or so. But it is temporarily bound to the Earth and is not in a stable orbit. It is heading away from the Earth-moon system and will likely escape in April. It will most likely return to orbiting the sun, although there’s a chance it could some day head straight to Earth, where it would burn up in the atmosphere in a dazzling meteor display.

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Human Hair can Cost Pigeon their Toes

THE hazard of *manjha*, used as a string for kite flying, as a cause of threat to humans and animals

has been in the news for quite some time. Now, a new threat has come to the fore that supposedly affects only pigeons. A study by researchers in the French capital has revealed that pigeons can lose their toes due to human hair. The details of the study have been published in the journal *Biological Conservation*.

The team of scientists from the National Museum of Natural History (NMNH) and the University of Lyon conducted a study on pigeons flocking in 46 sites across Paris. The study co-author Frederic Jiguet of NMNH said he came up with the idea for the study after noticing pigeons with mutilated toes as he walked through the Jardin des Plantes, a botanical garden in Paris.

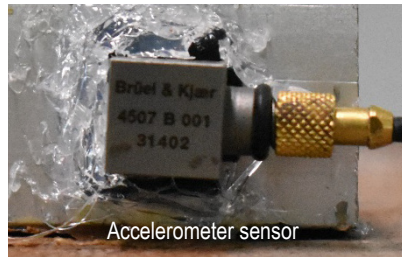
Monitoring the Health of a Structure Using Vibration-based Techniques

STRUCTURAL failures like the one in Dongri, Mumbai, 16 July 2019, and foot over bridge collapse near CST station in Mumbai 2019, can be devastating and so Structural Health Monitoring (SHM) is essential.

So far, the majority of SHM practices in India involve visual inspection and localised experimental methods that are mainly Non-destructive Testing (NDT) like ultrasonic methods, acoustic emission, etc. For large buildings like bridges and multi-storey complexes, the need for global monitoring arises that can look for the health of the structure as a single entity in its operational conditions.

Vibration-based health monitoring techniques serve this purpose. Vibration-based SHM is based on measuring the vibrational properties of a structure like frequencies and its vibrational patterns (technically speaking, mode shapes). Damage in a structure causes a change in its frequencies and vibrational pattern as compared to its undamaged case.

Vibration-based techniques try to find the location and the severity of the damage based on the measurement of the vibrations of a structure. This is done



using sensors (e.g., accelerometers), which measure the time history of vibrations.

For a building, the sensors can be installed at each floor and other critical locations to get sufficient accuracy. The data captured by all the sensors is analysed to get the vibrational frequencies and vibrational patterns of the structure. Damage in any portion of the structure causes changes in its structural properties, like stiffness, causing vibrational frequencies to drop and vibrational patterns to change. Any outlier in the vibration patterns alarms the owner for a potential damage location with corresponding damage severity.

Vibration-based monitoring is gaining huge attention worldwide. The Shanghai tower in China has 400 sensors installed along its height, continuously monitoring the structure. The Tsing Ma Bridge in Hong Kong is the longest suspension bridge and is being monitored since 1997 using sensors. In India, the Naini bridge in Prayagraj is being monitored continuously. The Signature Bridge over the Yamuna in Wazirabad, Delhi, is monitored by the Mageba ROBO® CONTROL SHM system.



However, the major hurdles in the widespread use of Vibration-based SHM are its cost, effectiveness under varying environmental conditions, and data handling capacity. Recent research works focus on achieving the same accuracy with a limited number of sensors. Developments in data management and data storing capabilities are further adding to its efficiency, opening doors for its popularity.

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Jiguet said the birds are “victims of our pollution, our activities”. The team found that pollution likely played a role in nearly all cases of missing or mutilated toes in pigeons. Pigeons living in areas with higher rates of air and noise pollution tended to have fewer digits than those that lived in leafier environs.

However, this is not the first explanation for the pigeons’ missing toes. The widespread belief is that pigeons get foot infections from sitting

on their own excreta. Some believe that chemicals and metal spikes used to deter them may also cause toe injury.

A very shocking fact came to the notice of the team that found that toe mutilation in pigeons “tended to increase with the density of hair dressers”. The human hair after being cut are disposed off as waste and this is the real culprit, said the researchers. Jiguet said that the pigeons could lose digits while getting stuck in human hair, a phenomenon called “string feet”.

Can mutilation of pigeon toes be an indication of the extent or level of pollution of a particular place? Commenting on this, Jiguet said, “It will be interesting to look in all major cities in the world, to look at how many toes pigeons have to estimate the quality of the environment and the pollution.”

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