SCIENCE NEWS

Major Hurdle Cleared to Diabetes Transplants

Researchers at Washington University School of Medicine in St. Louis have identified a way to trigger reproduction in the laboratory of clusters of human cells that make insulin, potentially removing a significant obstacle to transplanting the cells as a treatment for patients with type 1 diabetes.

Efforts to make this treatment possible have been limited by a dearth of insulin-producing beta cells that can be removed from donors after death, and by the stubborn refusal of human beta cells to proliferate in the laboratory after harvesting.

The new technique uses a cell conditioning solution originally developed to trigger reproduction of cells from the lining of the intestine.

"Until now, there didn't seem to be a way to reliably make the limited supply of human beta cells proliferate in the laboratory and remain functional," said Michael McDaniel, Ph.D. professor of pathology and immunology. "We have not only found a technique to make the cells willing to multiply, we've done it in a way that preserves their ability to make insulin."

The findings are now available online in *PLOS One*.

The current method for harvesting human islets, which are comprised primarily of the insulin-producing beta cells, makes it necessary to find two or three donors to extract enough cells to produce an adequate supply of insulin to treat a single patient with diabetes.

The idea for the new technique came from an on-campus gathering to share research results. Lead author Haytham Aly, Ph.D., a postdoctoral research scholar, reported on his work with beta cells and was approached by Thaddeus Stappenbeck, M.D., Ph.D., associate professor

of pathology and immunology, who studies autoimmune problems in the gut. Stappenbeck had developed a medium that causes cells from the intestine's lining to proliferate in test tubes.

"He said, why don't you try it, and he gave us some samples," Aly said. "We put the solution in our freezer for a month or so, and when we finally gave it a try, we were amazed at the results: human beta cells in Dr. Stappenbeck's solution reproduced at a rate that was 20 times higher than beta cells in a solution that contained the sugar glucose."

The ability to produce large quantities of human beta cells in the laboratory gives the researchers hope that they could one day be transplanted into patients with type 1 diabetes.

The advantage of Stappenbeck's solution may be that it is designed to activate multiple growth signaling pathways in cells, according to the researchers. Earlier attempts to make beta cells proliferate focussed on one or two growth pathways. The solution also activates genes that help prevent beta cells from dying.

Because pancreatic cancers are among the most deadly tumors, the scientists checked to make sure the proliferating beta cells weren't becoming more like cancer cells. They found that none of the factors known to contribute to pancreatic cancer were active in the laboratory-grown beta cells.

"This is an important concern to keep in mind if we are to expand human beta cells in culture with this medium and subsequently transplant them into patients," said Aly.

If the new availability of laboratory-grown beta cells makes it possible to treat patients with transplants from one donor instead of multiple donors, McDaniel noted, that might reduce the risk of immune system rejection of the transplants.

"Another benefit in using this novel growth medium to expand isolated human beta cells is that the cells remain healthier and have reduced levels of cell damage or death," Aly said. "That may also reduce the chances of immune system rejection."

Study of Oceans' Past Raises Worries About their Future

The ocean the Titanic sailed through just over 100 years ago was very different from the one we swim in today. Global warming is increasing ocean temperatures and harming marine food webs. Nitrogen run-off from fertilisers is causing coastal dead zones. A McGill-led international research team has now completed the first global study of changes that occurred in a crucial component of ocean chemistry, the nitrogen cycle, at the end of the last ice age. The results of their study confirm that oceans are good at balancing the nitrogen cycle on a global scale. But the data also shows that it is a slow process that may take many centuries, or even millennia, raising worries about the effects of the scale and speed of current changes in the ocean.

"For the first time we can quantify how oceans responded to slow, natural climate warming as the world emerged from the last ice age," says Prof. Eric Galbraith from McGill University's Department of Earth and Oceanic Sciences, who led the study. "And what is clear is that there is a strong climate sensitivity in the ocean nitrogen cycle."

The nitrogen cycle is a key component of the global ocean metabolism. Like the proteins that are essential to human health, nitrogen is crucial to the health of oceans. And just as proteins are carried by the blood and circulate through the body, the nitrogen in the ocean is kept in balance by marine bacteria through a complicated cycle that keeps the ocean healthy. The phytoplankton (microscopic organisms at the base of the food chain) 'fix' nitrogen in the shallow, sunlit waters of the ocean, and then as they die and sink, nitrogen is eliminated (a process known as 'denitrification') in dark, oxygen-poor pockets of the ocean depths.

Using sediment gathered from the ocean floor in different areas of the world, the researchers were able to confirm that as the ice sheets started melting and the climate warmed up at the end of the last ice age, 18,000 years ago, the marine nitrogen cycle started to accelerate. The ocean had stabilized itself in its new, warmer state, in which the overall nitrogen cycle was running faster, by about 8,000 years ago. Given the current dramatic rate of change in the ocean nitrogen cycle the researchers are not sure how long it will take for marine ecosystems to adapt.

"We are changing the planet in ways we are not even aware of," says Galbraith. "You wouldn't think that putting carbon dioxide into the atmosphere would change the amount of nitrogen available to fish in the ocean, but it clearly does. It is important to realise just how interconnected everything is."

This research was funded by the Canadian Institute for Advanced Research (CIFAR) through the Earth System Evolution Program

New Catalyst Neutralises Gases Responsible for Climate Change

New technology, developed by the Research Group in Carbon Materials and Environmental prevents nitrous oxide decomposing it into nontoxic products. The catalytic system is active, efficient and stable over time and can purify gases emitted by industries related to the production of fertilisers, plastics and coal burning plants to produce electricity or vehicles.

Nitrous oxide is a gaseous compound harmful to the environment which is related to the destruction of the ozone layer and the global warming. "Deleting all nitrous oxide emitted to the atmosphere due to human activities would be equivalent to reducing all emissions of greenhouse gases agreed in the Kyoto Protocol," Agustín Bueno López, researcher in the Carbon Materials and Environment Group explains.

The most promising method among those proposed for the removal of nitrous oxide consists of decomposing it into oxygen and molecular nitrogen which are the main components of air and therefore, they have no adverse effects on health or the environment. The main drawback is that temperatures above 625 °C are required so that this breakdown can take place spontaneously, and this temperature is much higher than that of polluted gas streams.

"However, nitrous oxide can be decomposed at lower temperatures using a suitable catalyst, but it usually comes along with other gases that inhibit the catalysts that were available heretofore, preventing its implementation on a full scale" Agustín Bueno explains.

Aiming to overcome the limitations, the present invention provides a novel catalyst system capable of working in the presence of inhibitors such as oxygen, other oxides of nitrogen and water vapour at temperatures below 450 °C, so it can be used in most of the sources emitting this pollutant gas.

"The catalytic decomposition is carried out by placing the catalyst in a fixed bed reactor through which the gas stream to be purified passes. The composition and temperature of the gas stream varies from source to source, and this is taken into account when implementing the catalyst," Agustín Bueno states.

The technology has been successfully tested in a real plant production of nitric acid and in the exhaust pipe of a state-of-the-art diesel engine, and the tests performed in the laboratory show that it can be applied to various chemical production plants, processes involving oxidation with ammonia, combustion processes of fossil fuels (coal, biomass, waste, etc.). and vehicle emissions (gasoline engines, diesel engines, etc.) among others.

Nanoparticle Opens the Door to Clean-Energy Alternatives

Cheaper clean-energy technologies could be made possible thanks to a new discovery. Led by Raymond Schaak, a professor of chemistry at Penn State University, research team members have found that an important chemical reaction that generates hydrogen from water is effectively triggered — or catalysed — by a nanoparticle composed of nickel and phosphorus, two inexpensive elements that are abundant on Earth.

The results of the research will be published in the *Journal of the American Chemical Society*.

Schaak explained that the purpose of the nickel phosphide nanoparticle is to help produce hydrogen from water, which is a process that is important for many energy-production technologies, including fuel cells and solar cells. "Water is an ideal fuel, because it is cheap and abundant, but we need to be able to extract hydrogen from it," Schaak said. Hydrogen has a high energy density and is a great energy carrier, Schaak explained, but it requires energy to produce. To make its production practical, scientists have been hunting for a way to trigger the required chemical reactions with an inexpensive catalyst. Schaak noted that this feat is accomplished very well by platinum but, because platinum is expensive and relatively rare, he and his team have been searching for alternative materials. "There were some predictions that nickel phosphide might be a good candidate, and we had already been working with nickel phosphide nanoparticles for several years," Schaak said. "It turns out that nanoparticles of nickel phosphide are indeed active for producing hydrogen and are comparable to the best known alternatives to platinum."

To create the nickel phosphide nanoparticles, team members began with metal salts that are commercially available. They then dissolved these salts in solvents, added other chemical ingredients, and heated the solution to allow the nanoparticles to form. The researchers were able create a nanoparticle that was quasi-spherical — not a perfect sphere, but spherical with many flat, exposed edges. "The small size

of the nanoparticles creates a high surface area, and the exposed edges means that a large number of sites are available to catalyse the chemical reaction that produces hydrogen," Schaak explained.

The next step was for team members at the California Institute of Technology to test the nanoparticles' performance in catalyzing the necessary chemical reactions. Led by Nathan S. Lewis, the George L. Argyros Professor of Chemistry at the California Institute of Technology, the researchers performed these tests by placing the nanoparticles onto a sheet of titanium foil and immersing that sheet in a solution of sulphuric acid. Next, the researchers applied a voltage and measured the current produced. They found that, not only were the chemical reactions happening as they had hoped, they also were happening with a high degree of efficacy.

"Nanoparticle technology has already started to open the door to cheaper and cleaner energy that is also efficient and useful," Schaak said. "The goal now is to further improve the performance of these nanoparticles and to understand what makes them function the way they do. Also, our team members believe that our success with nickel phosphide can pave the way toward the discovery of other new catalysts that also are composed of Earth-abundant materials. Insights from this discovery may lead to even better catalysts in the future."

In addition to Schaak and Lewis, other researchers who contributed to this study include Eric J. Popczun, Carlos G. Read, Adam J. Biacchi, and Alex M. Wiltrout from Penn State; and James R. McKone from the California Institute of Technology.

The research was funded by the U.S. National Science Foundation and the U.S. Department of Energy. The team has filed a patent application.

Martian Clay Contains Chemical Implicated in the Origin of Life, Astrobiologists Find

Researchers from the University of Hawaii at Manoa NASA Astrobiology Institute (UHNAI) have discovered high concentrations of boron in a Martian meteorite. When present in its oxidised form (borate), boron may have played a key role in the formation of RNA, one of the building blocks for life.

The work was published in *PLOS One*.

The Antarctic Search for Meteorites team found the Martian meteorite used in this study in Antarctica during its 2009–10 field season. The minerals it contains, as well as its chemical composition, clearly show that it is of Martian origin.

Using the ion microprobe in the W. M. Keck Cosmochemistry Laboratory at UH, the team was able to analyse veins of Martian clay in the meteorite. After ruling out contamination from Earth, they determined boron abundances in these clays are over 10 times higher than in any previously measured meteorite.

"Borates may have been important for the origin of life on Earth because they can stabilise ribose, a crucial component of RNA. In early life

RNA is thought to have been the informational precursor to DNA," said James Stephenson, a UHNAI postdoctoral fellow.

RNA may have been the first molecule to store information and pass it on to the next generation, a mechanism crucial for evolution. Although life has now evolved a sophisticated mechanism to synthesise RNA, the first RNA molecules must have been made without such help. One of the most difficult steps in making RNA nonbiologically is the formation of the RNA sugar component, ribose. Previous laboratory tests have shown that without borate the chemicals available on the early Earth fail to build ribose. However, in the presence of borate, ribose is spontaneously produced and stabilised.

This work was born from the uniquely interdisciplinary environment of UHNAI. The lead authors on the paper, Stephenson, an evolutionary biologist, and Lydia Hallis, a cosmochemist who is also a UHNAI postdoctoral fellow, first came up with the idea over an after-work beer. "Given that boron has been implicated in the emergence of life, I had assumed that it was well characterised in meteorites," said Stephenson. "Discussing this with Dr. Hallis, I found out that it was barely studied. I was shocked and excited. She then informed me that both the samples and the specialised machinery needed to analyse them were available at UH."

On our planet, borate-enriched salt, sediment and clay deposits are relatively common, but such deposits had never previously been found on an extraterrestrial body. This new research suggests that when life was getting started on Earth, borate could also have been concentrated in deposits on Mars.

The significance goes beyond an interest in the red planet, as Hallis explains: "Earth and Mars used to have much more in common than they do today. Over time, Mars has lost a lot of its atmosphere and surface water, but ancient meteorites preserve delicate clays from wetter periods in Mars' history. The Martian clay we studied is thought to be up to 700 million years old. The recycling of the Earth's crust via plate tectonics has left no evidence of clays this old on our planet; hence Martian clays could provide essential information regarding environmental conditions on the early Earth."

The presence of ancient borate-enriched clays on Mars implies that these clays may also have been present on the early Earth. Borate-enriched clays such as the ones studied here may have represented chemical havens in which one of life's key molecular building blocks could form.

UHNAI is a research center that links the biological, chemical, geological, and astronomical sciences to better understand the origin, history, distribution, and role of water as it relates to life in the universe.

A Microphone That Listens With Light: Microphones Have Hyper-Acute Hearing and a Sense of Direction

A sensor developed by scientists at SINTEF's MiNaLab will help to make microphones hypersensitive: "Think of traditional videoconference equipment. Several people are

sitting around the table, but the microphone has been placed where its sound reception is less than optimal. With technology of this sort, a microphone will be able to "see" where the sound comes from, pick up the voice of the person speaking, and filter out other sources of noise in the room," explains ICT researcher Matthieu Lacolle, who emphasises that acoustics scientists at SINTEF have also contributed to this innovative solution.

Small but tightly packed

The microphone is packed full of microelectronics. What makes it really special, however, is an optical position sensor that is no more than a millimetre in diameter.

The reason for giving a position sensor such an important role is that a microphone is completely dependent on a membrane, which picks up the pressure waves produced by the sound.

"In principle, a microphone acts like a drum. You have a membrane that vibrates when it is impacted by a sound — which is just a series of pressure waves. And then you have a reference surface in the background. The distance between these two surfaces registers the sound. We do this by measuring light waves from a microscopically small laser, so we can say that the sensor in microphones actually sees the sound," explains Lacolle.

The sensor can measure incredibly small movements, and thus also extremely quiet sounds. If we make the membrane light enough, and let it oscillate freely in the air, the microphone also becomes directionally sensitive. "That also tells us where the sound is coming from," says Lacolle, adding that the membrane is only 100 nanometres thick, almost 1,000 times thinner than a human hair.

Coloured by light

The technology that makes the microphone so sensitive is based on a combination of two optical phenomena; interference and diffraction, both of which are due to the wave character of light.

"If we hold up a CD to the light, we see the play of colours where it reflects the light. This happens because light consists of a spectrum of wavelengths that the naked eye perceives as colours, and these wavelengths are diffracted in different directions, explains Lacolle.

Another phenomenon that can be utilised to measure sound is interference, which occurs when a number of waves are superimposed on each other. You can observe this when you stand in a harbour where incoming waves are reflected by a pier and are superimposed on top of the waves that follow them into the harbour. Complex, apparently chaotic wave patterns can occur, but so do standing waves, which don't appear to move at all," says the SINTEF researcher.

What the SINTEF scientists did was to exploit optical diffraction and interference to measure membrane movements of less than the diameter of an atom by using the optimal sensor.

We have created very special grooved microstructures on the reference surface, which lies directly underneath the microphone

membrane. When the laser illuminates these microstructures, we can read off the direction in which the light is reflected by means of photodetectors, which transform the light into electrical signals."

Laboratory mass-production

The microphone thus consists of several elements: an ultrathin membrane, tiny grooved microstructures, a miniaturised laser and a number of photodetectors. Everything is integrated into a tiny circuit that is mass-produced on a silicon wafer on which all the structures are etched, using special equipment within a clean room.

Dust-free production

In MiNaLab's clean room, production takes place in a highly controlled environment. The production process is extremely sensitive; even a tiny grain of dust can destroy a whole production series, because it can affect the tiny microstructures.

"That's why our laboratory is equipped with vibration damping and air filters that take out particles as small as 100 nanometres," explains Lacolle.

Noise monitoring

The Norwegian company Norsonic supplies various types of noise-measurement equipment, and intends to use the new microphone to measure both sound pressure and acoustic power.

"The microphone is the very heart of the equipment that we supply. What is unique about this technology is that it can give us an extremely sensitive microphone that is capable of registering sound waves far beyond the range that microphones in this price class can do today. This lets us compete in a market that is currently occupied by very expensive equipment. Our version is also much smaller, which is an advantage in itself, because the physical size of the microphone actually affects the sound field that it is measuring," says senior scientist Ole Herman Bjor in Norsonic.

How the microphone works

In simple terms, we can say that the new microphone operates as follows:

- First, sound pressure is transformed into movements of the membrane.
- These movements are read optically via the light-sensitive detector.
- The light intensity is measured by a sensor which in turn transforms it into an electronic signal that is capable of reproducing the sound.

Other potential applications for the sensor include:

- Geophones for seismic shooting
- Photoacoustic gas sensors
- Accelerometers
- Vibration sensors
- Gyroscopes
- Pressure sensors
- High-temperature versions of the above-mentioned sensors
- Sensors for highly irradiated sites (nuclear power stations, x-ray equipment) or with electromagnetic radiation (sensors in motors or magnetic resonance equipment).

Cheetah-Cub: A Robot That Runs Like a Cat

Thanks to its legs, whose design faithfully reproduces feline morphology, EPFL's four-legged 'cheetah-cub robot' has the same advantages as its model: it is small, light and fast. Still in its experimental stage, the robot will serve as a platform for research in locomotion and biomechanics.

Even though it doesn't have a head, you can still tell what kind of animal it is: the robot is definitely modeled upon a cat. Developed by EPFL's Biorobotics Laboratory (Biorob), the 'cheetah-cub robot,' a small-size quadruped prototype robot, is described in an article appearing in the International *Journal of Robotics Research*. The purpose of the platform is to encourage research in biomechanics; its particularity is the design of its legs, which make it very fast and stable. Robots developed from this concept could eventually be used in search and rescue missions or for exploration.

This robot is the fastest in its category, namely in normalized speed for small quadruped robots under 30kg. During tests, it demonstrated its ability to run nearly seven times its body length in one second. Although not as agile as a real cat, it still has excellent auto-stabilisation characteristics when running at full speed or over a course that included disturbances, such as small steps. In addition, the robot is extremely light, compact, and robust and can be easily assembled from materials that are inexpensive and readily available.

Faithful reproduction

The machine's strengths all reside in the design of its legs. The researchers developed a new model with this robot, one that is based on the meticulous observation and faithful reproduction of the feline leg. The number of segments — three on each leg — and their proportions are the same as they are on a cat. Springs are used to reproduce tendons, and actuators — small motors that convert energy into movement — are used to replace the muscles.

"This morphology gives the robot the mechanical properties from which cats benefit, that's to say a marked running ability and elasticity in the right spots, to ensure stability," explains Alexander Sprowitz, a Biorob scientist. "The robot is thus naturally more autonomous."

Sized for a search

According to Biorob director Auke Ijspeert, this invention is the logical follow-up of research the lab has done into locomotion that included a salamander robot and a lamprey robot. "It's still in the experimental stages, but the long-term goal of the cheetah-cub robot is to be able to develop fast, agile, ground-hugging machines for use in exploration, for example for search and rescue in natural disaster situations. Studying and using the principles of the animal kingdom to develop new solutions for use in robots is the essence of our research."

Surgeons Implant Bioengineered Vein: Kidney Dialysis Patient First in U.S. to Receive Lab-Grown Blood Vessel

In a first-of-its-kind operation in the United States, a team of doctors at Duke University

Hospital helped create a bioengineered blood vessel and implanted it into the arm of a patient with end-stage kidney disease.

The procedure, the first U.S. clinical trial to test the safety and effectiveness of the bioengineered blood vessel, is a milestone in the field of tissue engineering. The new vein is an off-the-shelf, human cell-based product with no biological properties that would cause organ rejection.

Using technology developed at Duke and at a spin-off company it started called Humacyte, the vein is engineered by cultivating donated human cells on a tubular scaffold to form a vessel. The vessel is then cleansed of the qualities that might trigger an immune response. In pre-clinical tests, the veins have performed better than other synthetic and animal-based implants.

"This is a pioneering event in medicine," said Jeffrey H. Lawson, M.D., Ph.D., a vascular surgeon and vascular biologist at Duke Medicine who helped develop the technology and performed the implantation. "It's exciting to see something you've worked on for so long become a reality. We talk about translational technology — developing ideas from the laboratory to clinical practice — and this only happens where there is the multidisciplinary support and collaboration to cultivate it."

Clinical trials to test the new veins began in Poland in December with the first human implantations. The U.S. Food and Drug Administration recently approved a phase 1 trial involving 20 kidney dialysis patients in the United States, followed by a safety review. Duke researchers enrolled the first U.S. patient and serve as study leaders.

The initial trial focusses on implanting the vessels in an easily accessible site in the arms of kidney hemodialysis patients. More than 3,20,000 people in the United States require hemodialysis, which often necessitates a graft to connect an artery to a vein to speed blood flow during treatments. Current options have drawbacks. Synthetic vascular grafts are prone to clotting, leading to frequent hospitalizations, and harvesting veins from the patient's own body involves a separate procedure, with the risk of infection and other complications.

If the bioengineered veins prove beneficial for hemodialysis patients, the researchers ultimately aim to develop a readily available and durable graft for heart bypass surgeries, which are performed on nearly 4,00,000 people in the United States a year, and to treat blocked blood vessels in the limbs.
"We hope this sets the groundwork for how these things can be grown, how they can incorporate into the host, and how they can avoid being rejected immunologically," Lawson said. "A blood vessel is really an organ — it's complex tissue. We start with this, and one day we may be able to engineer a liver or a kidney or an eye."

The bioengineered vein is the product of a 15-year collaboration between Lawson and Laura Niklason, M.D., Ph.D., co-founder of Humacyte and a former faculty member at Duke who is now at Yale. Lawson and Niklason teamed up in the late 1990s after discovering they shared an interest in engineering blood vessels.

Building on work Niklason began as a bioengineering post-doctoral student, the duo worked to perfect the technology in animal

models and eventually moved to develop veins for human implantation.

"The bioengineered blood vessel technology is a new paradigm in tissue engineering," said Niklason, professor and vice chair of anesthesia, professor of biomedical engineering, Yale University, and founder of Humacyte. "This technology is a key step for patients with end-stage renal disease and can potentially avoid surgical interventions and hospitalisations. The fact that these vessels contain no living cells enables simple storage onsite at hospitals, making them the first off-the-shelf engineered grafts that have transitioned into clinical evaluation."

Overcoming setbacks and frustrations, the researchers notched numerous advancements, starting with the biodegradable mesh as the scaffolding for the veins. The mesh, easily manipulated into any shape, is formed into a blood vessel of varying lengths and widths.

When seeded with smooth muscle cells, the mesh gradually dissolves as the cells grow in a special medium of amino acids, vitamins and other nutrients. One key improvement, which strengthens the bioengineered tissue, is a pulsing force introduced during the growth process, in which the nutrients are pumped through the tube in a heartbeat rhythm to build the physical properties that are similar to native blood vessels.

After a couple of months, a life-like vein results.

Originally, the researchers sought to develop veins using a person's own cells to seed the scaffolding, reducing the risk that the patient's body would reject the implanted tissue. But growing personalised veins took too much time and ruled out mass production, so the researchers changed tack to develop a universal product.

Using donated human tissue to grow on the tubular matrix, they wash the resulting vein in a special solution to rinse out the cellular properties, leaving a collagen structure that does not trigger an immune response.

"At the end of the process, we have a non-living, immunologically silent graft that can be stored on the shelf and used in patients whenever they need it," Niklason said. "Unlike other synthetic replacements made of Teflon or Dacron, which tend to be stiff, our blood vessels mechanically match the arteries and veins they are being sewn to. We think this is an advantage."

When implanted in animals, the vein grafts actually adopt the cellular properties of a blood vessel. They don't just elude rejection; they become indistinguishable from living tissue as cells grow into the implant.

"They are functionally alive," Lawson said. "We won't know until we test it if it works this way in humans, but we know from the animal models that the blood travels through the blood vessels and they have the natural properties that keep the blood cells healthy."

Lawson's first patient, a 62-year-old man from Danville, Va., who has required kidney dialysis for years, received the bioengineered vein graft in a two-hour procedure on 5 June 2013.

Survival of the Galapagos Sea Lion

Immune systems of endangered Galapagos sea lions are in overdrive because of harmful activity by people, reveal scientists from the Zoological Society of London (ZSL).

The study shows that Galapagos sea lions (*Zalophus wollebaeki*) are more prone to starvation because of exposure to human influences like pets and pollution. These can impair the level of their immunity, making them less able to hunt and more likely to go hungry when food is scarce.

This research is published in *PLOS One*.

Conservationists spent more than 18 months on the Islands of San Cristobal, which is inhabited by humans, and Santa Fe, where there are no humans, dogs, cats, mice or rats. They tagged 60 Galapagos sea lions from each island and monitored their behaviour and physiology.

ZSL's Institute of Zoology Director, Professor Tim Blackburn says, "We are increasingly aware of the threats of infectious diseases to wildlife around the world, from amphibians in the tropics to the birds in British gardens. It is worrying that we are now potentially seeing such threats to sea lions in the supposedly pristine wilderness of the Galapagos Islands."

ZSL's Dr. Paddy Brock, author on the paper, says, "A tell-tale sign of an unhealthy sea lion is a thinner than normal layer of blubber, which is what we saw in the sea lions on San Cristobal. This was all the more notable as we didn't notice these patterns in sea lions on Santa Fe, where they live without the presence of people or pets.

"The immune systems of San Cristobel sea lions were more active, perhaps indicating a threat of infectious disease, which could mean human activity is increasing the chance of potentially dangerous diseases emerging in the Galapagos sea lion," Dr Brock added.

Despite laws designed to protect the unique wildlife found on the Galapagos, pets are regularly imported to the islands, which increases the risk of new diseases arriving and spreading to local species. In addition, dumping of sewage into the bay on San Cristobal where the sea lions live may be increasing their exposure to germs and bacteria associated with humans.

ZSL, together with collaborators, will continue to address the threats faced by the Galapagos sea lion by carrying out further research into the methods driving the described patterns, such as the role that genetics plays in shaping them.

What Do Memories Look Like?

Oscar Wilde called memory "the diary that we all carry about with us." Now a team of scientists has developed a way to see where and how that diary is written.

Led by Don Arnold and Richard Roberts of USC, the team engineered microscopic probes that light up synapses in a living neuron in real time by attaching fluorescent markers onto synaptic proteins — all without affecting the neuron's ability to function.

The fluorescent markers allow scientists to see live excitatory and inhibitory synapses for the first time and, importantly, how they change as new memories are formed.

The synapses appear as bright spots along dendrites (the branches of a neuron that transmit electrochemical signals). As the brain processes new information, those bright spots change, visually indicating how synaptic structures in the brain have been altered by the new data.

"When you make a memory or learn something, there's a physical change in the brain. It turns out that the thing that gets changed is the distribution of synaptic connections," said Arnold, associate professor of molecular and computational biology at the USC Dornsife College of Letters, Arts and Sciences, and co-corresponding author of an article about the research that appears in *Neuron* on 19 June.

The probes behave like antibodies, but they bind more tightly and are optimised to work inside the cell — something that ordinary antibodies can't do. To make these probes, the team used a technique known as 'mRNA display,' which was developed by Roberts and Nobel laureate Jack Szostak.

"Using mRNA display, we can search through more than a trillion different potential proteins simultaneously to find the one protein that binds the target the best," said Roberts, co-corresponding author of the article and professor of chemistry and chemical engineering with joint appointments at USC Dornsife and the USC Viterbi School of Engineering.

Arnold and Roberts' probes (called 'FingRs') are attached to green fluorescent protein (GFP), a protein isolated from jellyfish that fluoresces bright green when exposed to blue light. Because FingRs are proteins, the genes encoding them can be put into brain cells in living animals, causing the cells themselves to manufacture the probes.

The design of FingRs also includes a regulation system that cuts off the amount of FingR-GFP that is generated after 100 per cent of the target protein is labeled, effectively eliminating background fluorescence — generating a sharper, clearer picture.

These probes can be put in the brains of living mice and then imaged through cranial windows using two-photon microscopy.

The new research could offer crucial insight for scientists responding to President Barack Obama's Brain Research Through Advancing Innovative Neurotechnologies (BRAIN) Initiative, which was announced in April 2014.

Modeled after the Human Genome Project, the objective of the $100 million initiative is to fast-track research that maps out exactly how the brain works and "better understand how we think, learn and remember," according to the BRAIN Initiative website.

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