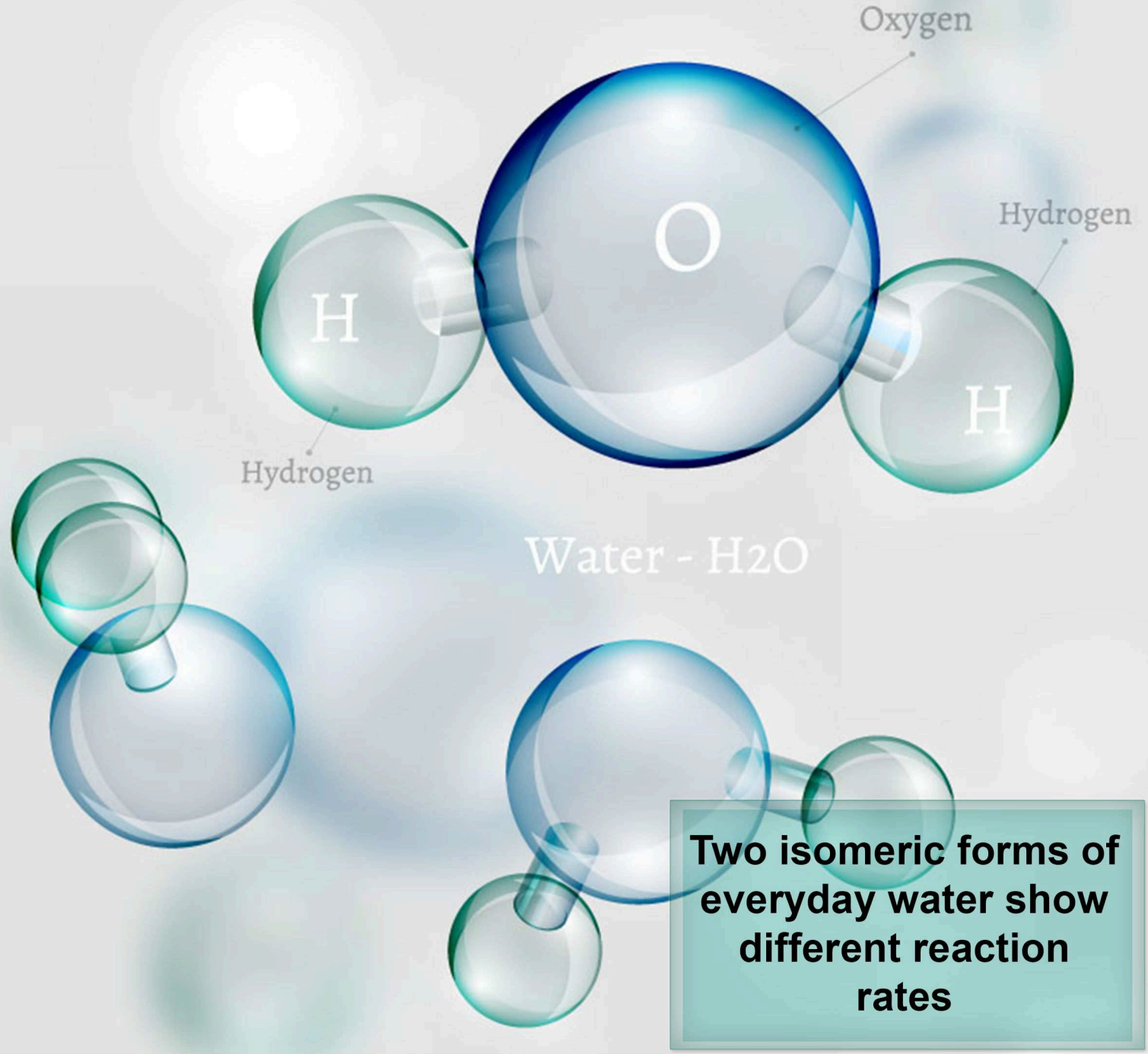
VOL.1/ ISSUE 6/ June 2018
ISSN 2515-9534 (Print)
ISSN 2515-9542 (Online)

Scientific European®

MONTHLY POPULAR SCIENCE MAGAZINE

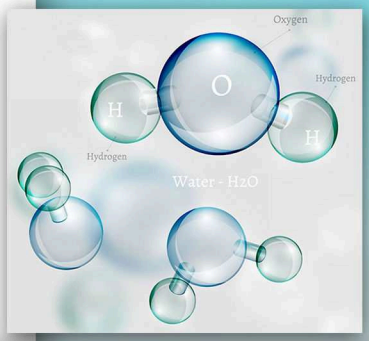


Two isomeric forms of everyday water show different reaction rates

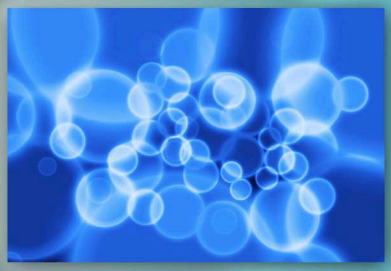
ISSN 2515-9542
06
9 772515 954000

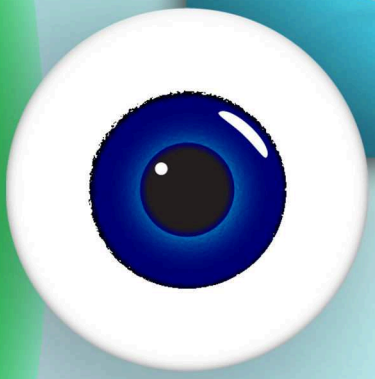
WWW.SCIENTIFICEUROPEAN.CO.UK
WWW.SCIEU.COM
Published by UK Education Consultancy Services Ltd, (Company Number 10459935 Registered in England);
Country of publication: United Kingdom


Adverse Effects
500mg
100% UNINTENDED CONSEQUENCE
100 tablets


Oxygen
Hydrogen
Hydrogen
Water - H2O


Recycle
Sustainable development
CO_2
Climate change
Environment
Energy saving



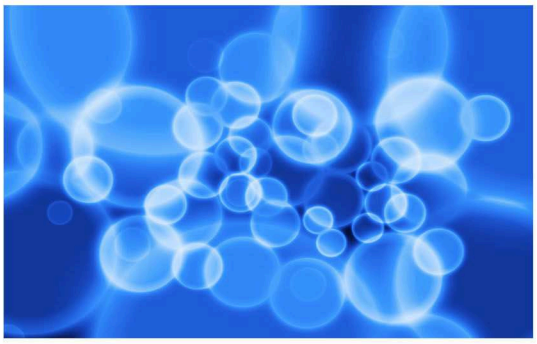


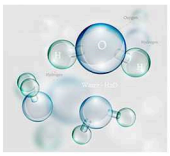

FIGHT AGAINST BREAST CANCER

Scientific European®

VOL. 1/ISSUE 6/ June 2018

Contents





SCIENTIFIC EUROPEAN PRINT EDITION ANNUAL SUBSCRIPTION
GBP 49.99
(Postal and VAT extra)

EDITOR-IN-CHIEF: *Umesh Parsad*
ADVISOR: *Syed Munir Hoda*
ADVISOR: *Rajeev Soni*
ASSOCIATE EDITOR: *Jasmita Gill*
CREATIVE & DIGITAL: *Carl Saunders*

NOTE FROM THE FOUNDER & EDITOR-IN-CHIEF

We are delighted to bring eight articles on latest scientific studies which hole great promise for mankind - novel cure for breast cancer, anti-ageing, medicines with fewer side effects, artificial cornea and more.

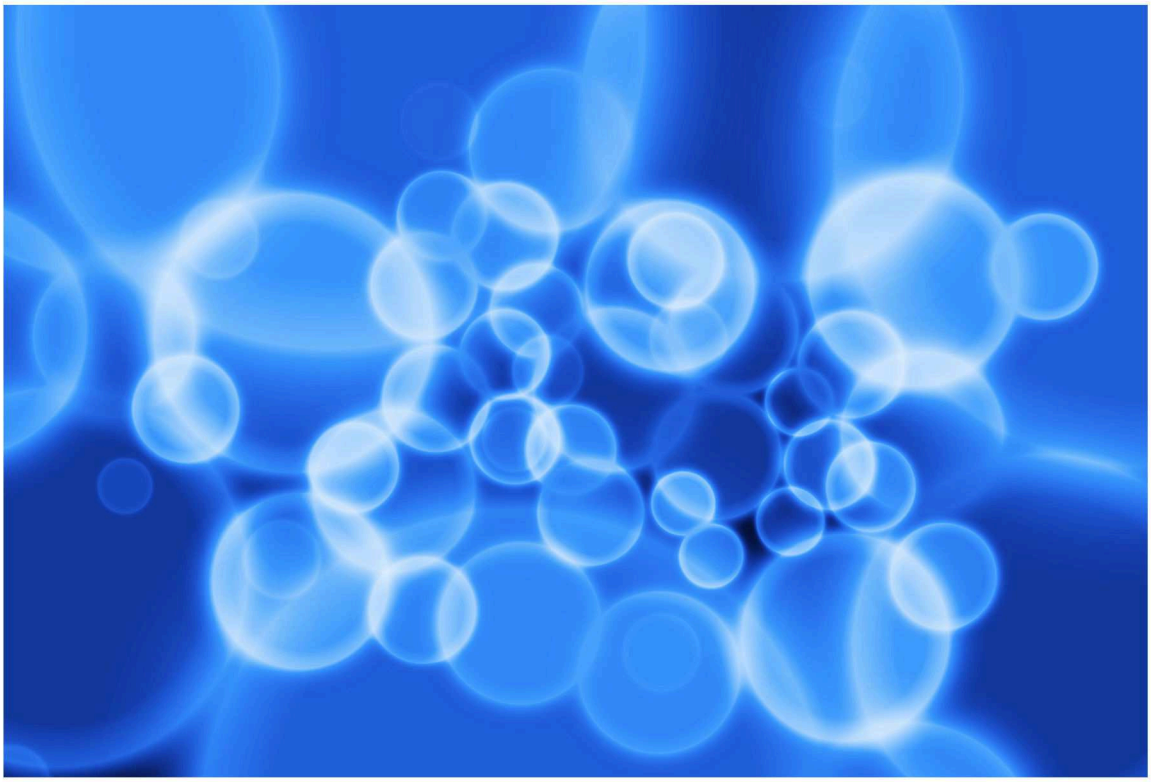
Hope you enjoy reading them!

Umesh Prasad

Publisher's statement: Scientific European® is both online and print science magazine published by UK Education Consultancy Services Ltd, (Company Number 10459935 Registered in England); city: Tadworth, Surrey; Country of publication: United Kingdom, ISSN 2515-9534 (Print), ISSN 2515-9542 (Online)

Smoothening the wrinkles 'inside' our cells: step ahead for anti-ageing

A new breakthrough study has shown how we could restore our cell's functionality and tackle the unwanted effects of ageing.



Ageing is a natural and an inevitable process because no living being is immune to it.Ageing is one of the biggest mysteries for humankind which still needs to fully understood. Scientists worldwide are researching on ageing, example why we get wrinkles on our faces or why we become weaker and fragile and more prone to medical ailments as we grow older. This is very fascinating area of research because the ageing process intrigues every human being and is a topic of debate for many. It is always believed that to be able to ward off ageing we must remain physically active, maintain our body weight etc. But even people leading very healthy lifestyles are prone to the cellular dysfunctions which are a part of a process as natural as ageing. To be able to understand ageing, research needs to be focused on unravelling the molecular mechanisms which are involved in the human ageing process. After gaining better insights, more efficient therapies can be designed to help us age better.

Understanding gene "turn off"

Every cell is our body expresses genes. In other words, some genes are "turned on" and the rest are "turned off". At a timepoint only very specific genes are turned on. This important process called gene regulation is a part of normal development. The genes which are turned off are placed against the nuclear membrane (which encompasses the cell nucleus). As we age, our nuclear membranes become lumpy and irregular, therefore the "turning off" of genes gets affected.The study says that the location of our DNA inside the cell's nucleus is very important.

Though we have the same DNA in every single cell but every cell is different. So, certain genes have to turned on in an organ say the liver but have to turned off in another organ and vice versa. And if this turning off is not done properly it can become an issue. This is the reason why gene regulation is very critical for normal development.

The new study published in Aging Cell by researchers at University of Virginia School of Medicine, USA, states that the unwanted effects of ageing may be a result of our cell's nucleus (which contains our DNA) becoming "wrinkly". And these wrinkles, researchers say, prevents our genes from functioning properly i.e. it prevents accurate required gene 'turn on' and 'turn off'. Researchers specifically looked at a model of fatty liver disease and found that our livers become lined with fat as we age because of the wrinkly nuclear membranes which are no longer functioning properly. This malfunction can lead to release of DNA from a gene which actually needed to be "turned off". And this sometimes becomes an 'overexpression' where it should be none i.e. an abnormal functionality happens. This ultimately causes the normal little liver cell to become a liver fat cell instead. This accumulation of fat inside the liver poses serious health risks including risk of type 2 diabetes, heart disease and even death.

Protection against unwanted effects of ageing

Researchers discovered that the cause of nuclear membrane becoming wrinkly is the lack of a substance called lamin (with age) which is crucial for cell functioning. Once lamin -a cellular protein which comes in many forms- was reintegrated back into the cells the membranes might be smoothed out and cells would function as if they were young again. It still remains tricky as how to deliver loads of lamin to specifically targeted cells inside i.e. the ones with the wrinkly membranes. Researchers thought of using custom-built engineered viruses for carrying out this delivery. Using such modes of mechanism that uses virus is now becoming a very exciting area of research as viruses are being successfully used to carry out specialized tasks in the body e.g. killing cancer cells or antibiotic-resistant bacteria. Particularly, liver has been an effective target for engineered-virus delivery methods. One study had shown the ability of viruses to deliver gene-regulating proteins directly into liver to help repair damage for patients suffering from liver fibroses. In the current study, once lamin is successfully delivered, the cells will behave like normal healthy cells because the things which do not need to be there will be removed.

Topic of ageing has social relevance

The subject of ageing is one of the key questions raised by individuals and society and it impacts all demographics. This new discovery should be applicable in cure or prevention of diabetes, fatty liver disease, other metabolic diseases where age is a risk factor. Also, it is possible that wrinkling of nuclear membrane might be responsible for unwanted effects in not just the liver (as shown in the current study) but universally speaking in other parts of the body as well. Example in many age-related diseases which affect other organs, the appearance of wrinkly membranes might be a big factor. It may be possible to turn back the clock on ageing in the body taking into account the understanding gained in this study on how the cells in our body degrade with age. This study has been done at a very early hypothetical level but certainly has huge implications on various diseases. Researchers even mention of an "anti-wrinkle" cream for our cells that are inside, similar to let's say retinol creams which are popularly used in smoothening wrinkles on our face. This appears to be a revolutionary breakthrough in anti-aging. Ageing research has the potential to impact lives. The subject of ageing is multidisciplinary and is relevant to not just life sciences but also economic researchers, psychologists and social scientists. ■

Source

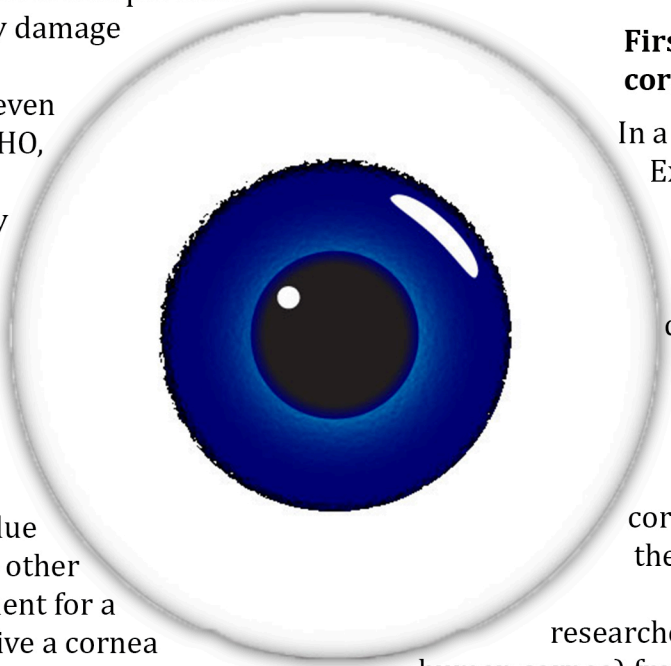
Whitton, Holly. 2018, 'Changes at the nuclear lamina alter binding of pioneer factor Foxa2 in aged liver', Aging Cell, vol. 17, no. 3, e12742 DOI: 10.1111/acel.12742

First artificial cornea

Scientists have for the very first time bioengineered a human cornea using 3D printing technique which can be a boost for corneal transplants.

Cornea is the transparent dome-shaped outermost layer of the eye.The cornea is the first lens through which light passes before hitting the retina at the back of the eye. Cornea plays a very important role in focusing vision by transmitting refracting light. It also provides protection to our eyes. Any damage or injury can cause severe impairment of vision and even blindness. According to WHO, around 10 million people worldwide require surgery to prevent corneal blindness which is caused as a result of a disease like trachoma or some eye disorder. Five million people suffer from total blindness which is caused by scarring of the cornea due to burns,abrasion or some other condition. The only treatment for a damaged cornea is to receive a cornea transplant, however,demand exceeds supply in corneal transplants. Also, there are many risks/ complications associated with corneal transplants including eye infection, use of stitches etc.

The most significant and serious problem is that sometimes the donor tissue (of cornea) is rejected after the transplant has been performed.This is a precarious situation, and though rare it does happen in 5 to 30 percent of the patients.



First 3D printed human cornea

In a recent study published in Experimental Eye Research, scientists at Newcastle University,UK have for the time used the three-dimensional (3D) printing technique to produce or 'manufacture' cornea for the human eye and this could a boon for getting corneas for transplant. Using the now well-established 3D bioprinting technology, researchers used the stem cells (of human cornea) from a healthy donor cornea andthey mixed them with alginate and collagen to create a solution that could be printed.This solution called the bio-ink is the most important requirement for printing anything in 3D.

Bioprinting is an extension of traditional 3D printing but applied to biological living materials and that is why a bio-ink needs to be used instead which is comprised of "living cell structures". Their unique gel-comprising of alginate and collagen- is able to keep the stem cells alive and at the same time produce a material which is firm enough to remain in a shape but is still soft to be able to get squeezed out of a 3D printer. Researchers used a simple, inexpensive 3D bio-printer in which the bio-ink which they prepared was successfully organized in concentric circles to form the dome-shape of an rtificial cornea. Also, the distinctive 'curved shape' of the cornea was achieved which makes this study a success. Researchers were ecstatic because this printing procedure took less than 10 minutes. The stem cells were then seen to be. growing

Ever since the popularity of 3D bioprinting has been on a rise, researchers worldwide have been looking to find the best suited ideal bio-ink for feasibly and efficiently make corneas. This group at Newcastle Universality has taken the lead and achieved it. The same group of researchers have earlier shown that they have kept cells alive for several weeks at room temperature within a simple gel of alginate and collagen. With this study they have been able to transfer this usable cornea with the cells remaining viable at 83percent for one week. So, it's a win-win scenario now because tissues could be printed without the concern whether they will grow or not (i.e. stay alive) since both the things are achievable in same medium.

Making patient-specific cornea

Researchers have also shown in this study that cornea could be built to match each patient's unique requirements. First, thepatient's eye is scanned which generates data to match the print cornea' to the exact shape and size required. So, dimensions are taken from the actual cornea itself which then makes the printing highly accurate and feasible. The 3D printing technology has been tested in producing artificial hearts and some other tissue. Flat tissues have been created in the past but according to the authors this is first time 'shaped' corneas have been produced. Though this method still requires healthy donor cornea, the stem cells are successfully used to grow into more cells in artificial cornea. On the positive note, one healthy cornea will just not 'replace' a damaged one but we could grow enough cells from one donated cornea to print 50 artificial corneas. This will be a much more beneficial scenario than just doing a single transplant.

Future

This study is still at a preliminary stage and the 3D printed corneas need to be further evaluated. Researchers state that their work will take several years before such an artificial cornea can be used for transplants because animal and human trials are still to be carried out. It also needs to be checked if this material is functional, lots of fine-tuning is needed. Researchers are confident of these artificial corneas to be available for practical use within the next 5 years. Availability of 3D printing technology is not a problem now as its become inexpensive and bioprinting (of living tissues) is emerging well and there might be standard procedures available in few years' time. More focus is now going towards using stem cells to rebuild or replace damaged tissues while the printing portion of the method is mostly streamline.

This study is a promising advancement and one day this technology could treat blindness in millions of people. It would be nothing short of a miracle to be able to potentially generated this part of a vital organ like eye and help patients who have suffered corneal damage. So, this study is a significant step towards a solution which can give us an unlimited supply of corneas for transplant worldwide. Further, researchers at an Italian company are even thinking in the direction of eventually creating '3D printed eyes' Which would be constructed in a similar

by using potential bio-ink that encompasses the obvious cells required to replace those found in a natural set of eyes. The bio-inks could be varied in different combinations depending upon the specific requirement. They are aiming to have these "artificial eyes" in the market by 2027. This is huge. This study has produced the most advanced form of artificial cornea and has highlighted bioprinting as potential solution to organ and tissue shortages. ■

Source

Isaacson A, Swioklo S, Connon C. 2018, '3D bioprinting of a corneal stroma equivalent', Experimental Eye Research, DOI: 10.1016/j.exer.2018.05.010

Novel *cure for* breast Cancer

In an unprecedented breakthrough, a woman with advanced breast cancer spread in her body showed complete regression of the disease- by harnessing the power of her own immune system to fight cancer

Key points

- Immunotherapy is a type of treatment that simply uses certain parts of a person's own immune system to fight diseases like cancer.
- The case report simply and effectively illustrates the power of immunotherapy to treat a patient suffering from metastatic breast cancer.
- Researchers have already planned large scale clinical trials to assess the effectiveness of this therapy for more number of patients.

Breast cancer is the most common cancer in women worldwide both in the developed and less developed world. Breast cancer is also the most common cancer in women. Approximately 1.7 million new cases are diagnosed every year and breast cancer represents 25% of all cancers in women. Treatment of breast cancer depends on the stage and generally requires one or more of following procedures - chemotherapy, radiation therapy, hormone therapy and surgery. Metastatic breast cancer, i.e. when the cancer has spread from the breast onto other areas of the body, remains incurable. Urgent ways are needed to target and stop the spread of this fatal disease.

Breakthrough in treating metastatic breast cancer

Immunotherapy is a type of treatment that simply uses certain parts of a person's own immune system to fight diseases like cancer.This method involves stimulating your own immune system to work more efficiently to attack cancer/tumour cells in the body. In a novel study led by Dr Steven A. Rosenberg,Chief of the Surgeryat the National Cancer Institute (NCI), researchers have developed a unique approach to immunotherapy for treating cancer1. They developed a high-throughput method to identify mutations which are present in cancer (cells) and which can be recognized by the immune system. All cancers have mutations and those are being "targeted" or "attacked" in this immunotherapy method. The new therapy is a modified form of ACT (adoptive cell transfer) which has been earlier used in effectively treating melanoma (skin cancer) in which there are high number of acquired mutations. However, this method has been less effective for cancers which generally start at the tissue lining of organs, like stomach, ovarian and breast. This study as the authors state is at a very early level and mostly experimental but is definitely promising.

A woman patient of 49 years of age with advanced and late-stage metastatic breast cancer (i.e. spread to other parts of her body) went through a clinical trial of this novel method. She had previously received multiple treatments, including several rounds of chemotherapy and hormonal treatments, but all these had failed to stop the progress of cancer in her right breast and it was already spreading to liver and other areas of her body. The tumours were also affecting her nerves leading to shooting pains in the body. She had given up and was mentally preparing herself that her condition was unresponsive to treatments, fast deteriorating and she has only about three more years to live. This was the mental situation she was in when she came for the trial. To be able to apply the immunotherapy treatment on her, researchers sequenced DNA and RNA from a normal tissue and from one of her malignant tumours by cutting them into small pieces. This way they could carefully findmutations that were specifically present in her cancer. They were able to identify 62 different mutations in her tumour cells by looking at mainly four disrupted genes which were then responsible for producing abnormal proteins inside the cancer cells.

Researchers also extracted "immune cells" (tumour infiltrating lymphocytes or TILs) from tumours biopsies in order to understand how the patient's immune system invaded the tumour and tried to kill it but obviously failed and hence the cancer persisted. Immune system fails when its fighter cells are weak or few in number. Researchers analysed almost a billion of expanding immune cells or TILs in the laboratory and screened to shortlist particular immune cells which were effective in killing the tumours by recognising the abnormal proteins which were produced by the gene mutations in the first place. They then injected almost 80 billion selected immune cells into the patient's body along with a standard drug called pembrolizumab which helps the immune system to fight cancer.

Remarkably, after this treatment the patient was and has remained completely cancer free for almost 22 months now. The patient thinks of this as some kind of miracle and it really is. This novel immunotherapy published in Nature Medicine has shown to very effectively kill cancer cells. In an ongoing phase 2 clinical trial2, scientists are developing a form of ACT which used TILs that specifically target tumour cell mutations to see if they can be shrunk for cancers like of the breast after being infused back into the patient. The goal is to create a stronger immune response against the tumour.

Future

This case report simply and effectively illustrates the power of immunotherapy because our immune system is believed to be quite powerful. It is a remarkable study since breast cancer, like prostrate and ovarian cancers, has very few mutations which then makes it more difficult for the immune system to spot and mark them as unhealthy tissue. Though experimental at this stage, this new approach is very promising becauseit uses immunotherapy which is dependent upon mutations and not the type of cancer so in that sense it could be used for treatment of many types of cancer. So, this kind of treatment could be "not cancer-type specific". It has already generated hope in treating incurable metastatic breast cancer (which don't have many antigens) after getting success with one patient and thus treating other "difficult" cancers like prostrate and ovarian should be achievable.It looks promising to be effective on the range of tumours on which previously known methods of immunotherapy have not worked very well. The study is thrilling but needs to be repeated for other patients to actually evaluate its success.Researchers have already planned large scale clinical trials to assess the effectiveness of this therapy for more number of patients.Scientists believe that it is still a long way before such a therapy could be available in routine care for patients.


FIGHT BREAST
AGAINST CANCER

Scientists believe that it is still a long way before such a therapy could be available in routine care for patients. Such therapies are extremely complex and expensivebecause it requires infiltration into the immune cells of the patient's and the expansion of these cells is also not possible in all cases. Nevertheless, breakthrough study has definitely given direction to the elusive goal of targeting several mutations in cancer through immunotherapy. ■

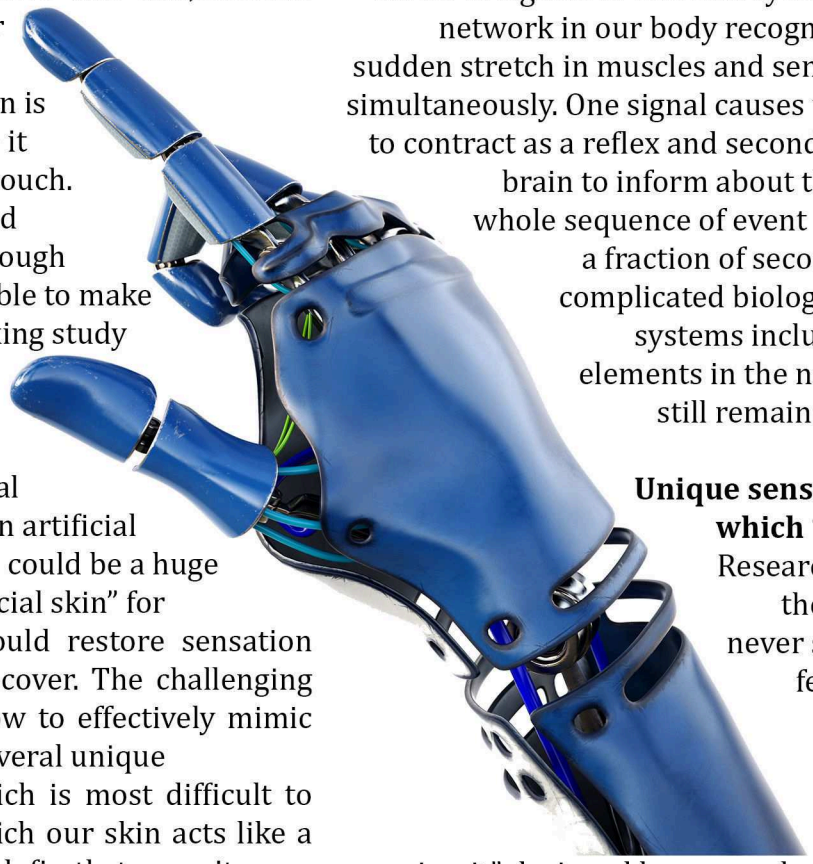
Source

1. Zacharakis, Nikolaos et al. 2018, 'Immune recognition of somatic mutations leading to complete durable regression in metastatic breast cancer'. Nature Medicine, DOI: 10.1038/s41591-018-0040-8
2. US National Library of Medicine, 'Immunotherapy Using Tumor Infiltrating Lymphocytes for Patients With Metastatic Cancer' accessed June 6, 2018 <https://clinicaltrials.gov/ct2/-show/NCT01174121>

Artificial sensory nerve system: a boon for prosthetics

Researchers have developed an artificial sensory nerve system which can process information similar to the human body and it could effectively give sense of touch to prosthetic limbs

Our skin is the body's largest organ is also the most important as it covers our entire body, controls our body temperature and protects us from harmful external factors like sun,bnormal temperatures,germs etc. Our skin can remarkably stretch and can repair itself. The skin is also very important because it provides us with a sense of touch. Skin is a complex sensing and signalling system for us. Through this sense of touch, we are able to make decisions. In a ground-breaking study published in Science, researchers led by Prof Zhenan Bao at Stanford University and Seoul National University have developed an artificial sensory nerve system which could be a huge step towards creating "artificial skin" for prosthetics limbs which could restore sensation and act like a normal skin cover. The challenging aspect of this study was how to effectively mimic our skin which possesses several unique properties. The feature which is most difficult to mimic is the manner in which our skin acts like a smart sensory network which firstly transmits sensations to the brain and also orders our muscles to react through a reflex to make prompt decisions.



For example, a tap causes elbow muscles to stretch, and sensors in these muscles send impulse to the brain through a neuron. The neuron then sends a series of signals to relevant synapses. The synaptic network in our body recognizes the pattern of sudden stretch in muscles and sends out two signals simultaneously. One signal causes the elbow muscles to contract as a reflex and second signal goes to the brain to inform about this sensation. This whole sequence of event happens in almost a fraction of second. Mimicking this complicated biological sensory nerve systems including all functional elements in the network of neurons still remains very challenging.

Unique sensory nerve system which "mimics" the real

Researchers have created their unique sensory never system which they feel would replicate how the human nervous system functions.The "artificial nerve circuit" designed by researchers integrates three components into a flat, flexible sheet measuring few centimetres.

These components have individually been described previously. The first component is a touch sensor which can detect forces and pressure (even mini ones). This sensor (made of organic polymers, carbon nanotubes and gold electrodes) send signals through a second component, a flexible electronic neuron. Both these components are enhanced and improved versions of what was developed by same researchers before. Sensory signals generated and passed through these two components are delivered to a third component, an artificial synaptic transistor which is modelled exactly like human synapses in the brain. All these three components have to work cohesively and demonstrating the end function was the most challenging aspect which was achieved by the group. The real biological synapses relay signals and also store information which is required to take decisions. This synaptic transistor "performs" these functions by delivering electronic signals to the synaptic transistor by using the artificial nerve circuit. Therefore, this artificial system learns to recognize and react to sensory inputs based upon the intensity and frequency of low-power signals, just how a biological synapse would do in a living body. The novelty of this study is how these three individual components that are known previously were integrated successfully for the first time to deliver a cohesive system.

Through the experiments which they performed, researchers tested for the ability of this system to generate reflexes and also sense touch. In one such experiment they attached their artificial nerve to a cockroach leg and applied tiny pressure to their touch sensor. The electronic neuron converted the sensor signal into digital signals and passed them through the synaptic transistor. This caused the cockroach's leg to twitch based upon the pressure increase or decrease in the touch sensor. So, this artificial setup certainly activated the twitch reflex. In a second experiment, researchers exhibited the ability of the artificial nerve in detecting different touch sensations by being able to differentiate Braille letters.

In another test they rolled a cylinder over the sensor in different directions and were able to accurately detect the exact direction of the motion. Thus, this device is able to improve object recognition and fine tactile information processing like texture recognin, braille reading and distinguishing edges of objects.

Future of artificial sensory nerve system

Authors state that this artificial nerve technology is at a very early stage and has not reached the required complexity level but has given immense hope for creating artificial skin coverings. However, it is clear that such "coverings" would also require devices to detect heat, vibration, pressure and other forces and sensations. They have to have a good ability of getting embedded into flexible circuits so that they can effectively interfaced with the brain. To really mimic our skin, device needs to have more integration and functionality which shall make it more stable and reliable.

This artificial nerve technology could be a boon for prosthetics and restore sensations to amputees. The prosthetic devices have improved a lot over the year with more 3D printing technology available and more responsive robotics systems. Despite these upgrades, most prosthetic devices available today have to be controlled in a very rough manner as they do not a good satisfying interface with the brain because of the lack of incorporation of the intricoes of vast human nervous system. The device does not give feedback and thus the patient feels very dissatisfied and discards them sooner or later. Such an artificial nerve technology when successfully incorporated into prosthetics will deliver touch information for users and will help provide the patients with a far better experience. This device is a big step towards making skin-like sensory neural networks for

various applications by granting powers of reflex and touch sense. Another example, as the group states, they aim to create neuro-prosthetic devices, soft robots, low-power artificial sensors nets to cover robots make it more agile and be able to provide some of the feedback which humans derive naturally from their skin. ■

Source:

Yeongin Kim et al. 2018, "A bioinspired flexible organic artificial afferent nerve'. Science, DOI: 10.1126/science.aao0098

Cost effective way to convert plants into renewable source of energy

Scientists have shown a new technology in which bioengineered bacteria can makecost-effective chemicals/polymers from renewable plant sources

Lignin is a material which is a constituent of cell wall of all dry land plants. It is the second most abundant natural polymer after cellulose. This material is the only polymer found in plants which is not composed of carbohydrate (sugar) monomers. Lignocellulose biopolymers provide shape, stability, strengthand rigidity to plants. Lignocellulose biopolymers consist of three main components: cellulose and hemicellulose form a framework in which lignin is incorporated as a kind of connector, thus solidifying the cell wall. Cell wall lignification makes plants resistant to wind and pests and helps them from rotting. Lignin is a vast but very underutilized renewable resource of energy. Ligninwhich represents up to 30 percent of the lignocellulose biomass, is an unexploited treasure – at least from a chemical point of view.

The chemical industry depends mostly on carbon compounds for creating different products like paint, artificial fibres, fertilizers and most importantly plastic. industry does use some renewable resources like vegetable oil, starch, cellulose etc but this comprises only 13 percent of all compounds.

Renewable source of energy

Lignin, a promising alternative to petroleum for making products

In fact, lignin is the one and only source of renewable onearththat contains a large number of aromatic compounds.This is of importance because aromatic compounds are generally extracted from the non-renewable source petroleum and then are used to produce plastics, paints etc. Thus, the potential of lignin is very high. And, in comparison to petroleum which is a non-renewable fossil fuel, lignocelluloses are derived from wood, straw or Miscanthus which are renewable sources.Lignin can be grown in fields and forests and are generally neutral towards the climate Lignocelluloses is being considered as a serious alternative to petroleum in the past few decades.

Petroleum drives the chemical industry at present. Petroleum is a raw material for many basic chemicals which are then used to produce useful products.Lignin can be grown in fields and forests and are generally neutral towards the climate Lignocelluloses is being considered as a serious alternative to petroleum in the past few decades.

But petroleum is non-renewable source and is dwindling, therefore focus needs to be on finding renewable sources. This brings lignin into the picture as appears to be a very promising alternative.

Lignin is full of high energy but retrieving this energy is complicated and an expensive process and thus even biofuel generated as the end result is generally very high on cost and cannot economically replace the "transportation energy" currently in use.Many approaches have been researched for developing cost effective ways of breaking down lignin and converting it into valuable chemicals. However, several limitations have restricted the conversion of a touch plant matter like lignin to being used as an alternative energy source or even try making it more cost effective.

A recent study has successfully engineered bacteria (E. Coli) into acting as an efficient and productive bioconversion cell factory. Bacteria grow and multiple very fast and they are able to withstand harsh industrial processes. This information was combined with the understanding of naturally available lignin degraders. The work was published in the *Proceedings of the National Academy of Sciences of the United States of America.*The team of researchers led by Dr Seema Singh at the Sandia National Laboratories, Livermore, solved three main problems that are encountered in turning lignin into platform chemicals. The first major hurdle is that bacteria E.Coligenerally does not produce the enzymes which are needed for the conversion. So, scientists tend to solve this problem of making enzymes by adding an "inducer" to the fermentation ring. These inducers are effective but are very expensive and thus do not fit well in the concept of biorefineries. Researchers tried a concept wherein a lignin derived compound like vanilla was used as a substrate as well as an inducer by engineering the bacteria E.Coli. This would totally bypass the need for an expensive inducer. Though, as the group discovered, vanilla wasn't a good choice particularly because once lignin breaks down, vanilla is produced in large quantities and it starts inhibiting the functioning of E.Coli.

In other words, vanilla starts creating toxicity. But this worked in their favour when they engineered the bacteria.

In the new scenario, the very chemical that is toxic to the E.Coli is used to initiate the complex process of "lignin valorisation". Once the vanilla is present, it activates the enzymes and the bacteria starts to convert vanillin into catechol, which is the desired chemical. Also, the amount of vanillin never reaches the toxic level as it gets autoregulated in the current system. The third and final problem was of the efficiency. The system of conversion was obviously slow and passive, thus researchers looked into possible more effective transporters from other bacteria and engineered them into the E. Coliwhich then fast trackedthe process.

It is well established that once lignin is broken down, it has the ability to provide or rather "bestow upon" valuable platform chemicals which can then be converted to nylon, plastics, pharmaceuticals and other important products which are currently derived from petroleum, a non-renewable energy source.This study is relevant in being a big step towards researching and developing cost-effective solutions for biofuel and bioproduction. Thus, using such bioengineering technology, we can produce larger quantities of platform chemicals and several other new end products, not just with bacterial E.Coli but even with other microbial hosts.

Authors' future research shall focus on demonstrating an economical production of these products. This research has a huge impact on not just energy generation processes but also in the expansion of the range of possibilities for green products. The authors comment that in the near future lignocellulose should definitely complement petroleum if not replace it. ■

Source

Weihua Wu, Fang Liu, Seema Singh 2018, 'Toward engineering E. coli with an autoregulatory system for lignin valorization', Proceedings of the National Academy of Sciences, vol. 115, no.12, DOI: 10.1073/pnas.1720129115

Scientific European®

A MONTHLY POPULAR SCIENCE MAGAZINE

ISSN 2515-9534 (Print)
ISSN 2515-9542 (Online)

Find us online!

Read any article, issue on any device

Subscribe now at

scieu.com
www.scientificeuropean.co.uk

For general enquiries write to info@scieu.com
For editorial enquires write to editors@scieu.com

Direct capture of carbon dioxide from air: promising way to tackle carbon footprint and fuel generation

Study had shown a scalable and affordable solution of directly capturing carbon dioxide from air and tackling carbon footprint

Carbon dioxide (CO2) is a major greenhouse gas and a significant driver of climate change. A greenhouse gas in the atmosphere is capable of absorbing infrared radiation. Through this entrapment, it traps and holds heat and increase in this heat causes the greenhouse effect which ultimately leads to global warming. Therefore, sucking CO2 right out from air has the potential to help abate climate change. If this capturedCO2is once again released into the air (e.g. when gasoline is burned), no new greenhouse gas is getting added into the atmosphere. Basically, recycling of greenhouse gas emissions is efficiently taking place.

Direct capture of carbon dioxide

In a recent highly interesting study published in Joule,carbon dioxide (CO2) which is generated by directly capturing from air can be then processed for removal of carbon. This can enable us to produce carbon-neutral hydrocarbons which could be a better alternative for carbon-free sources that are currently used like solar or wind.

A Canadian company called Carbon Engineering, a CO2-capture and clean fuel enterprise worked in collaboration with Harvard University to achieve this. The company is founded by Prof David Keith who is also a professor of Physics at Harvard University

The idea of direct air capture technology is very straightforward. Giants fan are used to draw ambient air into contact with an aqueous solution which sucks out CO2 from the air,-cheaply and directly and then traps it.

This carbon dioxide is then stick into a liquid. Using heating and some chemical reactions this carbon dioxide is re-extracted (or separated from the liquid). Finally, carbon dioxide is now prepared for further use. Example, it is mixed with some hydrogen to turn this whole thing into combustible fuels like gasoline. The end goal is usingthis carbon as a source for making valuable chemicals like fuels. Carbon Engineering have successfully achieved CO2 capture and fuel generation. The idea of direct air capture has been around for quite a while. But this is the first time that a pilot plant study taking care of scalability and cost-effectiveness has been successfully implemented. Using standard industrial equipment, the plants by this company look capable of manufacturing 2,000 barrels of fuel in a day which could translate to 30 million gallons per year across their plants. Prof Keith claims that direct air capture will cost roughly $94-$232 per ton of carbon dioxide captured which is quite reasonable.This cost is effectively lower compared to the value being set at $1000 per ton in theoretical analyses carried out by different research groups. At this low price of $94-$232 per ton, direct air capture could easily take on around 20percent of global carbon emissions. These emissions are a result of flying, driving, basically transportation needs worldwide. And, the fuels which could be prepared from this direct air capture method are compatible with existing fuel distribution and also the type of transport which is used.

Key points

- In direct capture, giant fans are used to draw ambient air into contact with an aqueous solution which sucks out CO2 from the air, cheaply and directly and then traps it.
- The first time a pilot plant study taking care of scalability and cost-effectiveness has been successfully implemented.
- The fuels which could be prepared from this direct air capture method are compatible with existing fuel distribution and also the type of transport which is used.

Thus, the technology would remain the same but a more efficient and environment friendly way to deliver this technology would be adapted.

Researchers state that these desired results which have been achieved after decades of practical engineering and cost analysis. They are optimistic and confident that this technology is viable, buildable and scalable for producing carbon-neutral fuels in the near future. This can help to reduce the carbon footprint and there could be a possibility of even removing carbon altogether in the long run.They aim to complete the full study on a much larger industrial scale by 2021. This study opens up the possibility of stabilising the climate at an affordable and practical price without majorly altering an energy system (e.g. transportation). ■

Source

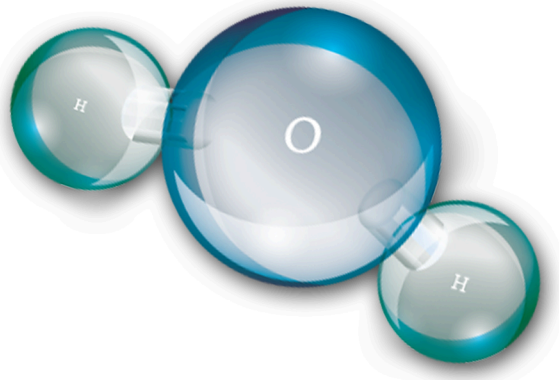
Keith et al. 2018, 'A process for capturing CO2 from the atmosphere', Joule, DOI: 10.1016/j.joule.2018.05.006


Recycle
Sustainable development
CO_2
reenhouse gas
Climate change
Environment
Industry
Energy saving

Two isomeric forms of everyday water show different reaction rates

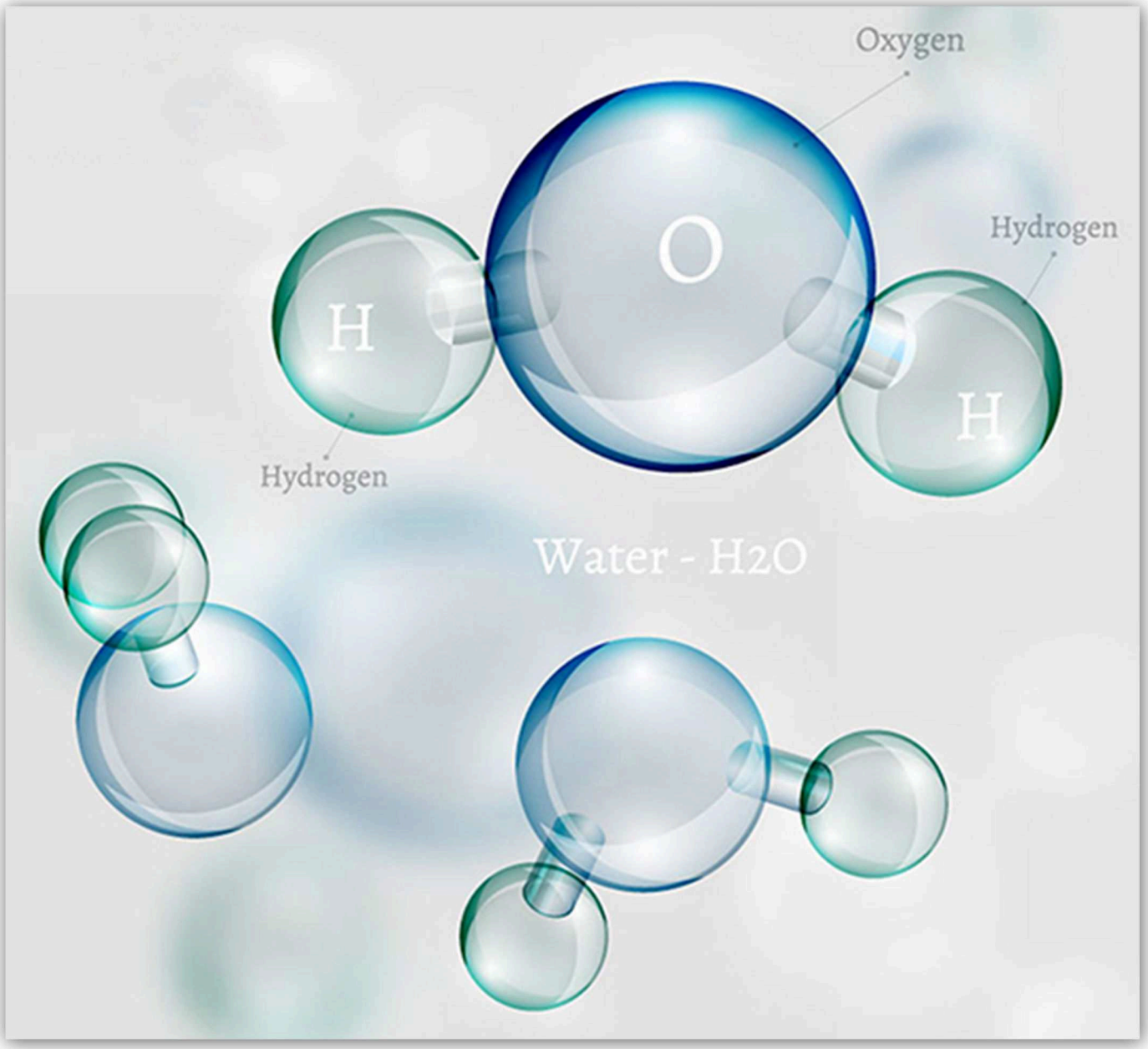
Researchers have investigated for the first time how two different forms known of water behave differently when undergoing chemical reactions

Water is a chemical entity, a molecule in which a single oxygen atom is linked to two hydrogen atoms (H2O). Water exists as liquid, solid (ice) and gas (vapours). It is among the few chemicals which do not contain carbon and still can be liquid at room temperature (about 20 degrees). Water is ubiquitous and important for life. At the molecular level it is well known that everyday water exists in two different forms but this information is not of common knowledge.These two forms of water are called isomers and are referred to as ortho- or para-water. The main difference between these forms is very subtle and is simply the relative orientation of the nuclear spins of the two hydrogen atoms which are aligned in either same or opposite direction, hence their names. This spin of hydrogen atoms is due to atomic physics though this phenomenon is not yet fully understood. These two forms have identical physical properties and it has been believed so far that they shouldalso then have identical chemical properties.



In a recent study published in Nature Communications, researchers from the University of Basel, Hamburg have for the first time investigated the difference in chemical reactivity of these two forms of water and have proven that ortho- and para- forms react very differently. Chemical reactivitymeans the way or the ability by which a molecule undergoes a chemical reaction. The study involved separation of water into its two isomeric forms (ortho- and para-) using an electrostatic deflector by involving electric fields. Since both these isomers are practically the same and have identical physical properties, this separation process is complex and challenging. The separation was achieved by this group of researchers by using a method based of electric fields developed by them for Free-Electron Laser Science. The deflector introduces an electric field to a beam of atomized water. Since there is crucial difference in nuclear spin in the two isomers, this slightly impacts the way by which atoms interact with this electric field. Therefore, as the water travels through the deflector it starts separating into its two forms ortho- and para-

Researchers have demonstrated that para-water reacts around 25 percent faster than ortho-water and its able to attract to a reaction partner more strongly. This is definitely explained by the difference in the nuclear spin which influences the rotation of the water molecules. Also, para- water's electrical field is able to attract the ions faster. The group further performed computer simulations of water molecules to corroborate their findings.



All experiments were done with molecules in very low temperature settings almost -273 degrees Celsius. This is an important factor as explained by the authors that only in such conditions the individual quantum states and energy content of molecules can be well defined and better controlled. Which means that water molecule stabilizes as either of its two forms and their differences become obvious and clear.

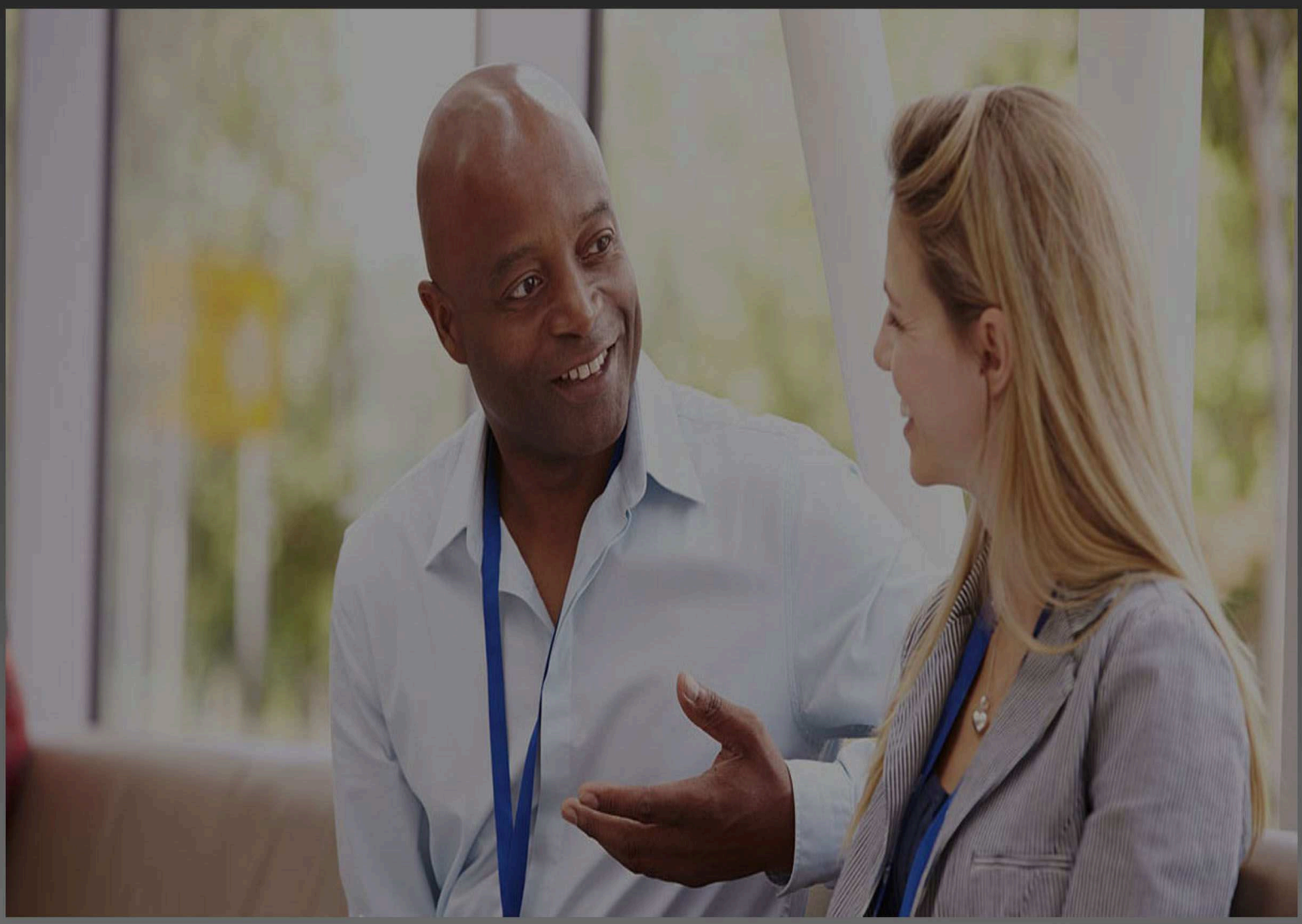
Thus, investigating chemical reactions can then reveal underlying mechanisms and dynamics leading to a better understanding. However, the practical use of this study might not be very high at this time. ■

Source

Kilaj, A. 2018, 'Observation of different reactivities of para and ortho-water towards trapped diazenylium ions', Nature Communications, vol. 9, no.1
DOI: 10.1038/s41467-018-04483-3

UK EDUCATION ®

...helping you realise your dreams



Programmes and Courses

MEDICAL, DENTISTRY AND HEALTH SCIENCES

LAW, LEGAL STUDIES AND CRIMINOLOGY

and more

www.uk-education.com

info@uk-education.com

We aim to help students realise their dreams by providing them comprehensive advisory and support services in accomplishing their career and immigration aspirations and by helping them in goal setting and devising appropriate strategies for achieving them.

A way forward in developing medicines with fewer unwanted side effects

A breakthrough study has shown a way forward to create medicines/drugs which have fewer unwanted side effects than we have today

Medicines in today's times comes from a variety of sources. Side effect in medication is a big headache. The unwanted side effects in medicines which are either rare or common are majorly annoying and sometimes can be very serious. A medicine which has no or fewer mild side effects can be used by a larger majority of medicines which have more serious side effects can be used only in circumstances where no other alternative is available and would also require monitoring. Ideally, medicines which have fewer or no unwanted side effects shall be a boon for medical therapy. It's a major goal and also a challenge for researchers worldwide to develop new medications which contain no serious side effects.

The human body is a very complex structure built from chemicals which need to be regulated for smooth functioning of our system. Most medicines consist of a mix of chemical compounds. These chemical compounds are composed of molecules. The important molecules are called "chiral molecules" or enantiomers. The chiral molecules look identical to each other and contain the same number of atoms. But they are technically "mirror images" of each other i.e. one half of them are left-handed and the other half are right-handed. The important aspect here is this difference in their "handedness" leads them to produce different biological effects. This difference has been studied thoroughly and it has been pointed out that the correct chiral molecules are extremely important for a medicine/drug to make the correct impact, otherwise "wrong" chiral molecules can produce undesired results. The separation of chiral molecules is a very crucial step for drug safety. This process if not simple, is quite expensive and generally requires customized approach for each molecule type. Lot of research has been conducted in this area, but it has failed to develop a cost-effective simplistic separation process.

Therefore, we are still far away from a time when all medicines on the shelf at a pharmacy will contain no side effects.

Looking at why medicines have side effects

In a recent study published in Science, researchers from Hebrew University of Jerusalem and Weizmann Institute of Science have discovered a uniform non-specific method by which the separation of left and right chiral molecules in a chemical compound can be achieved easily in a cost-effective manner1. Their work sounds very pragmatic and simple. The method which they have developed is based upon magnets. Chiral molecules interact with a magnetic substrate and assemble according to the direction of their "handedness". That is, "left" molecules interact with a particular pole of the magnet, while "right" molecules interact with the other pole. This technology sounds logical and useful and can be used by chemical and pharmaceutical manufacturers to keep the good molecules (whether left or right) in a medicine and remove the bad ones which are responsible for causing harmful or undesired side effects.

Improving medicines and more

This is definitely a breakthrough study and will play a major role in developing better and safer drugs using simple and cost-effective separation method. Some popular drugs today are sold in their chirally-pure forms (i.e. separated form) but this statistic stands at only about 13% of all drugs available in the market. Thus, separation is highly recommended by drug administration authorities. Revised guidelines must be met by pharmaceutical companies to incorporate this and make medicines that are more safe and reliable. This study could play a role beyond medicines and also for food ingredients, food supplements etc. Following such guidelines could elevate the quality of food products and can help improve lives will cause less contamination to the environment and willcontribute towards higher yields. This simple separation carried out for chemical compounds (which are to be consumed) has surprisingly a long list of goodness attached to it and will be a boon to many sectors .

Another study done by researchers at Australian National University has shown how understanding the molecular details of how drug or medicine works can help us to find a way to reduce unwanted side effects in them2. The team of researchers for the first time specifically carried out studies at molecular levels to look for similarities across six pharmaceutical drugs which are used for pain relief, dentist anesthetic and in treatment of epilepsy. They ran bigger and more complex computer simulations using supercomputers to map the picture of how these drugs were behaving. They mapped clues about molecular details on how these drugs might be affecting one part of the body and would unintendedly cause an undesired side effect in another part of the body. Such molecular level understandings can critically guide scientists and they must be incorporated in all drug discovery and design studies. This also brings about the possibility of modifying the structure of existing drugs or making new drugs which would have reduced unwanted side effects.

Do these studies mean there will be a day very soon where medicines will have no side effects whether mild or serious. Maybe not so soon, because our body is a highly complex system and many mechanisms in our body are interlinked to each other. However, these studies have led to a promising conclusion that firstly there is hope to have medicines or drugs which have very few and mild side effects which are well-understood. Secondly, the serious side effects of medicines if there should be understood as well and medical practitioners will have access to more information on how the prescription and sale of such medicines is brought under control to avoid fatalities.

Source
1. Banerjee-Ghosh, Koyel et al 2018, 'Separation of enantiomers by their enantiospecific interaction with achiral magnetic substrates', Science, eaar4265 DOI: 10.1126/science.aar4265

2. Amanda Buyan, Delin Sun, Ben Corry 2018, 'Protonation state of inhibitors determines interaction sites within voltage-gated sodium channels', Proceedings of the National Academy of Sciences, 201714131

WORLD CONFERENCE

...helping to converge and collaborate

www.worldconference.co.uk
info@worldconference.co.uk

Upcoming Events

World Conference on Molecular Biology of Cancer
15th to 17th August 2018, Lausanne, Switzerland

World Conference on New Approaches in Genome Engineering
16th to 18th September 2018, Basel, Switzerland

Our Services

Conferences on specific topic, symposia and colloquia

Congress, on general theme or area

and more

We are a team of experienced individuals proficient in academia, research and industry with proven track records of strategizing innovative solutions and evolving creative lateral thinking for various business-related challenges.