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SAFE DRINKING WATER

HOME-BASED LOW COST WATER PURIFIER

The Challenge of Safe Drinking Water: A Novel Solar Powered Home-based, Low Cost Water Purification System

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NOTE FROM EDITOR-IN-CHIEF

We bring to you 11 articles on latest advancements in science including a novel water purifier, new technology for solar cells, gene therapy for repairing heart, implications of diet on health, a new method to treat anxiety and many more..

Hope you enjoy reading them!

Umesh Prasad

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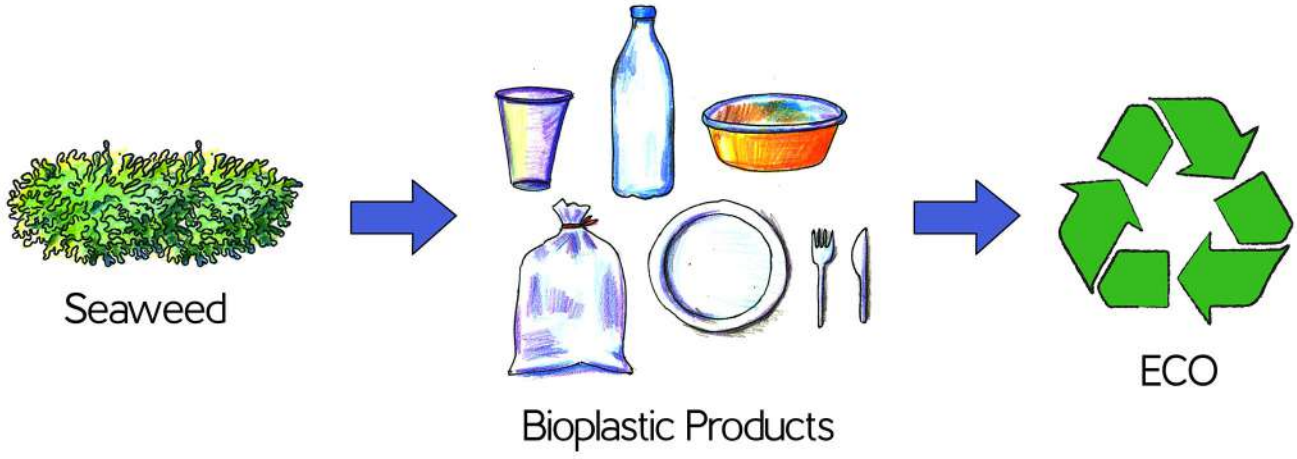
Exploiting Biocatalysis to Make Bioplastics

By Rajeev Soni

A plethora of avenues exist where biocatalysis and biotransformation reactions can be used for human and environmental benefit

The objective of this brief article is to make the reader aware of the importance of biocatalysis and how it can be used for the benefit of mankind and the environment. Biocatalysis refers to the use of biological agents, be it enzymes or living organisms to catalyse chemical reactions. The enzymes utilized can be in an isolated form or expressed within the living organism when the organism is used for catalyzing such a reaction. The advantage of using enzymes and living organisms is that they are very specific and do not yield unrelated products that is observed when using chemicals to carry out such reactions. Another advantage is that enzymes and living organisms work at less harsher conditions and are ecofriendly as opposed to chemicals being used for such transformations.

The process of catalyzing the reaction using enzymes and living organisms is known as biotransformation. Such biotransformation reactions not only occur in vivo within the human body (liver being the preferred organ; where cytochrome P450s are used to convert xenobiotics to water soluble compounds that



can be excreted from the body), but also can be utilized ex vivo using microbial enzymes to perform reactions that are beneficial for mankind.

A plethora of avenues exist where biocatalysis[1] and biotransformation reactions can be used for human and environmental benefit. One such area which warrants the use of such a technology is the production of plastic material, be it for manufacturing bags, cans, bottles or any such container (s), as chemically made plastics pose a huge threat to the environmental biodiversity and are non-biodegradable. They accumulate in the environment and are not able to get rid of easily. The use of enzymes and living organisms to produce bioplastics, plastics that can be easily biodegradable and pose no threat to environment would go a long way in not only reducing the chemically derived plastic waste but also help in sustaining ecosystems and prevent our flora and fauna from becoming extinct. The biodegradable containers made of bioplastic material would find use in several industries such as agri industry, food packaging, beverages and pharmaceuticals.

A variety of technologies exist today to produce bioplastics[2-4] . Some have been validated in the laboratory while others are still in the stage of infancy. Researches globally are working on such technologies to make them cost-effective[5] and scalable so that they can be taken up to produce bioplastics in an industrial setting. These bio-plastics can ultimately substitute chemically made plastics.

Source(s)

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2. Fai Tsang Y et al. 2019. Production of bioplastic through food waste valorization. Environment International. 127. DOI: 10.1016/j.envint.2019.03.076

3. Costa SS et al. 2019. Microalgae as source of polyhydroxyalkanoates (PHAs) - A review. Int J Biol Macromol. 131. DOI: 10.1016/j.ijbiomac.2019.03.099

4. Johnston B et al. 2018. The Microbial Production of Polyhydroxyalkanoates from Waste Polystyrene Fragments Attained Using Oxidative Degradation. Polymers (Basel). 10(9). DOI: 10.3390/polym10090957

5. Poulopoulou N et al. 2019. Exploring Next-Generation Engineering Bioplastics: Poly(alkylene furanoate)/Poly(alkylene terephthalate) (PAF/PAT) Blends. Polymers (Basel). 11(3). DOI: 10.3390/polym11030556

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Excessive Intake of Protein for Bodybuilding May Impact Health and Lifespan

Study in mice shows that excessive long-term intake of dietary protein containing high amounts of branched-chain amino acids (BCAAs) can result in imbalance in amino acids and appetite control. This affects metabolic health and causes reduced lifespan

A healthy diet should contain balanced amounts of macronutrients (protein, carbohydrate and fats), fibres, vitamins and minerals. Numerous researches have focused on the importance of balanced amounts of dietary protein, fats and carbohydrates for our good health. Any imbalance in proportions of these macronutrients in our diet is known to cause ill-health.

Protein is a complex macromolecule composed of amino acids. There are 20 amino acids, of which nine are essential which can enable the body to make the remaining 11. The branched-chain amino acids (BCAAs) are made up of three of the nine essential amino acids– leucine, isoleucine and valine. Muscles, the main building block of the body are mainly composed of proteins. BCAAs are broken down in muscle, have high calories and are consumed for muscle mass they provide. BCAAs are present in protein foods like red meat, eggs, beans, lentils, soy protein etc. and are also commonly present in bodybuilding protein supplements consumed after exercise or workout. Not enough studies

have been done to evaluate the adverse effects of consuming excessive BCAAs. Their long-term effects on health and lifespan are still unknown.

precursor of hormone serotonin which has mood elevating effects and thus is crucial for promoting sleep. Once trypto phan was blocked from

In a study published in *Nature Metabolism* researchers aimed to determine how manipulating long-term dietary BCAAs might have an effect on health and lifespan. In their experiments conducted on mice, the animals consumed for their entire life span either (a) normal amount of BCAAs i.e. 200 percent (b) half the amount i.e. 50 percent or (c) one fifth of the amount i.e. 20 percent. Alongside, mice were given isocaloric, fixed amounts of other macronutrients – carbohydrates and fat. Intake of excessive BCAAs led to high amounts of BCAAs in blood and this appeared to block transport of another non-BCAA tryptophan to the brain. Tryptophan is the sole reaching the brain, this led to depletion of central serotonin levels resulting in excessive eating (or hyperphagia) in mice primarily due to the amino acid imbalance via increased ratio of BCAAs-:non-BCAAs. Thus, mice overconsumed food (both total energy and BCAAs) – also called compensatory feeding – resulting in increased body weight and fat mass thus making them obese and shortening their lifespan.

This study shows that the relationship between increased levels of circulating BCAAs in blood and adverse health outcomes do not appear to belinked to intrinsic BCAA toxicity or

harmfulness. The relationship was due to the interactions between BCAAs and other important amino acids and this was what led to extreme hyperphagia. Results suggest that taking high amounts of dietary BCAAs for long-term along with fixed amounts of other macronutrients can result in hyperphagia driven by amino acid imbalance and affect metabolic health and reduce lifespan. Although high amounts of BCAAs can occur in both metabolically healthy and unhealthy mice. Therefore, BCAA alone cannot be the only biomarker for metabolic health.

The current study re-establishes the importance of consuming a healthy balanced diet containing variety of macronutrients, fibres, vitamins and minerals and restricting intake of unneeded supplements.

Source(s)

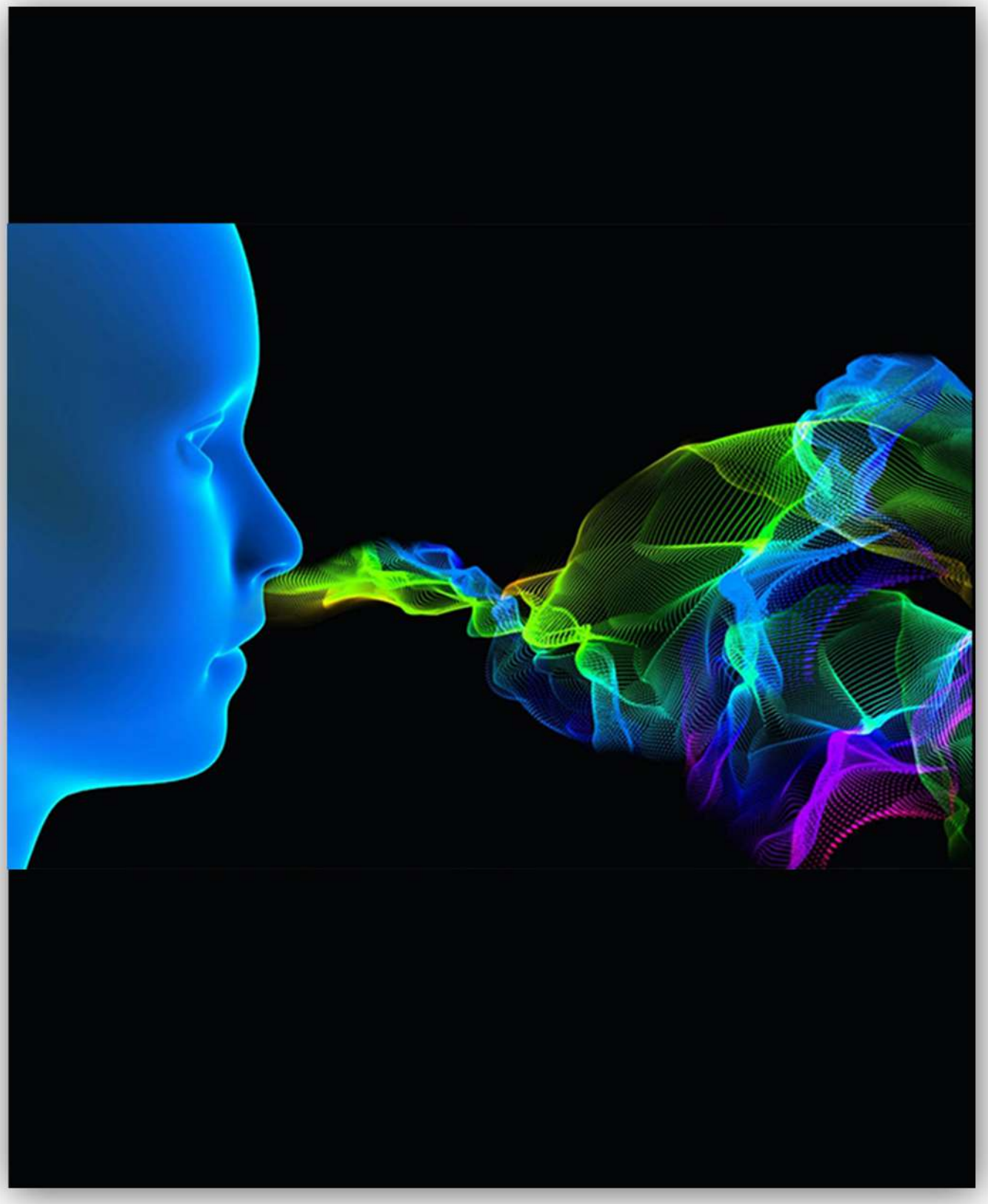
Solon-Biet SM et al. 2019. Branched-chain amino acids impact health and lifespan indirectly via amino acid balance and appetite control. Nature Metabolism. DOI: 10.1038/s42255-019-0059-2 ■

Decline in Sense of *Smell May be Early Sign of Health* Deterioration *Among Elderly*

A long follow up cohort study shows that loss of sense of smell could be an early predictor of health problems and higher mortality among older adult

It is well known that as we age our senses start to decline including sight, hearing and also sense of smell. Studies have shown that poor sense of smell is an early sign of Parkinson's disease, dementia and is also asso-ed with weight loss. However, these studies have been limited by their duration and lack of follow ups. The link between poor sense of smell and poor health outcomes is not well established. A new study published in *Annals of Internal Medicine* aimed to assess the relationship between this sensory deficit and higher mortality in older adults.

In the current community-based cohort study, researchers utilized data from National Institute of Aging USA' Health ABCD study. They evaluated information for a period of 13 years from around 2,300 older adult participants including men and women of different racial background (white and black) who were between the ages of 71 and 82. The information was collected from smell identification tests of 12 common odours including cinnamon, lemon and smoke. Based upon this information the participants were classified as having (a) good (b) moderate or (c) poor sense of smell. The health outcomes and survival of the participants were then tracked at 3, 5, 10 and 13 years Evaluations indicated that compared to older adults with good sense of smell, the individuals



with poor sense of smell had 46 percent higher cumulative risk of death within 10 years and 30 percent higher risk within 13 years. The results were considered unbiased as they were mostly unaffected by gender, race or lifestyle factors. Further, the participants who were healthier at the beginning of the study developed higher risks. The higher mortality was attributed to neurodegenerative disorders (like dementia) and weight loss and to some extent cardiovascular diseases. Respiratory illnesses or cancer were not seen to be linked with loss of sense of smell.

The current study suggests that among the older adult population, having a poor sense of smell indicates almost 50 percent more risk or likelihood of dying within 10 years. This was also true for healthy individuals who had no ailments or health issues. Thus, poor sense of smell could be an early warning of deteriorating health before any other signs or symptoms of an ailment appear. One limitation of the study is the aspect that this correlation accounted for only around 30 percent cases of increased mortality among participants. For the remaining 70 percent cases higher mortality is unclear and could be most likely related to chronic health issues. Nevertheless, it is suggested that sense of smell screening or olfactory tests must be included in routine check-ups for older adults alongside the currently done standards tests for vital signs, hearing and vision. This study elucidates a possible connection between sense of smell and mortality and requires further studies.

Source(s)

Bojing L 2019. Relationship Between Poor Olfaction and Mortality Among Community-Dwelling Older Adults. Annals of Internal Medicine. DOI: 10.7326/M18-0775

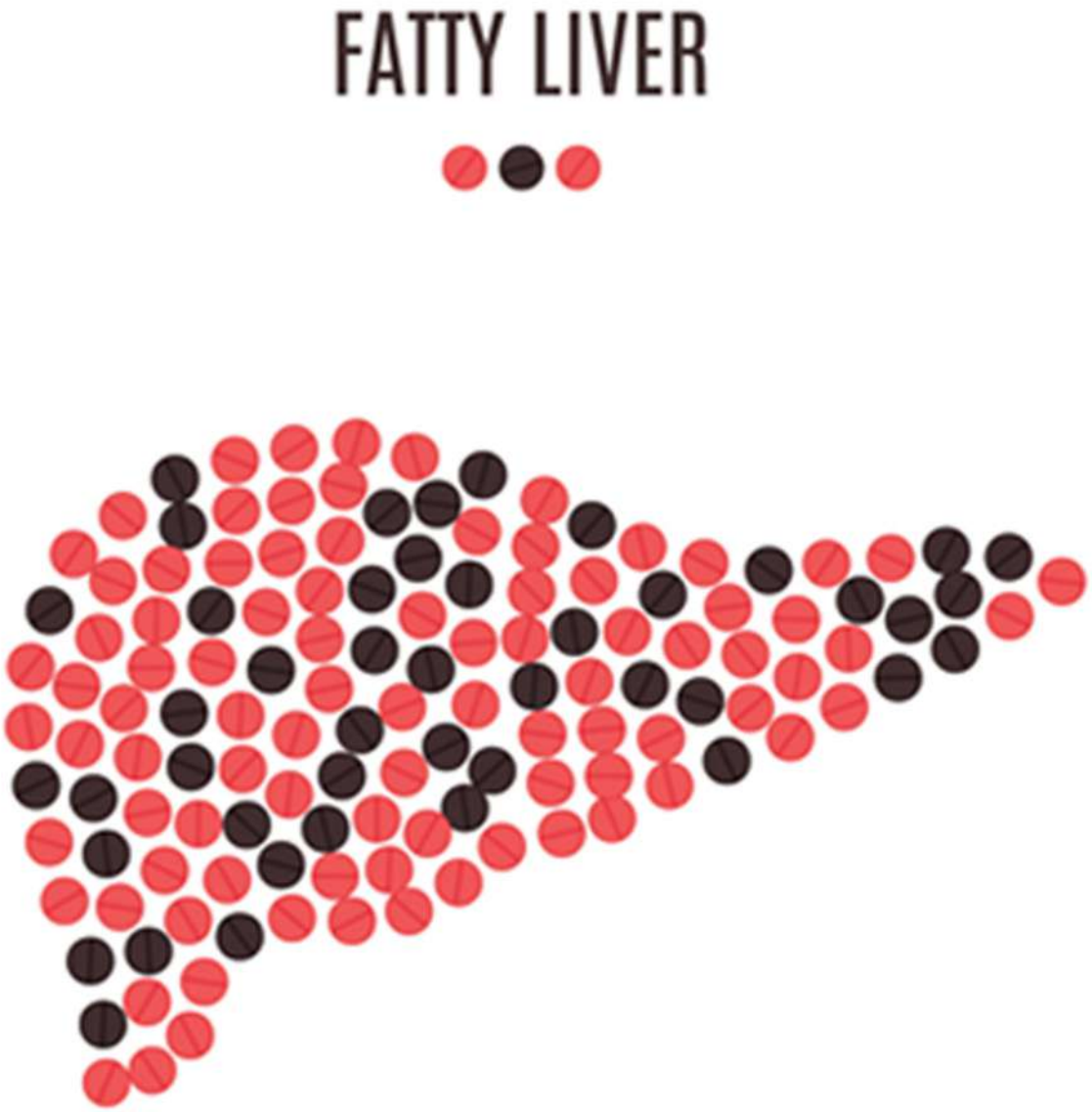
■

An Update in *Understanding of Non-alcoholic Fatty Liver* Disease

Study describes a novel mechanism involved in progression of non-alcoholic fatty liver disease and highlights protein Mitofusin 2 as having the potential to be a possible treatment model

Non-alcoholic fatty liver disease is the most common liver condition which affects people who drink no or very little alcohol. It affects 25 percent of global population and is quite prevalent in developed countries. The condition is characterized with accumulation of extra fat in hepatic cells leading to different liver dysfunctions. This condition is difficult to diagnose at an early stage. No treatment is available for non-alcoholic fatty liver disease and doctors generally recommend losing weight. In a serious form of this disease called non-alcoholic steatohepatitis (NASH), fat accumulation is accompanied by inflammation, cell death and fibrosis.

A study published in *Cell* proposes a new possible therapeutic target for treating non-alcoholic fatty liver disease. Researchers have identified a mitochondrial protein called Mitofusin 2 which could be one of the factors that can provide protection against this condition. In their study they saw that levels of Mitofusin



2 protein were seen to be low in patients suffering from NASH as seen from their liver biopsies. The lower levels were present even in the early stages of NASH indicating that this disease develops when Mitofusin 2 protein decreases in the liver cells. A similar scenario was seen in hepatic cells of a mouse model of non-alcoholic fatty liver disease .In mice the decrease in levels of Mitofusin 2 was responsible for hepatic inflammation, abnormal lipid metabolism, liver fibrosis and liver cancer.

In experiments conducted on a mouse model of NASH, mice were placed under a chow diet for 2 weeks and adenoviruses encoding Mitofusin 2 protein were intravenously injected into mice. The virus was specifically modified to artificially express the proteins. The livers of these mice were analyzed after 1 week. Results showed that condition of NASH was seen to improve in mice with significant improvement in lipid metabolism.

Detailed experiments revealed that membrane protein Mitofusin 2 directly binds to and aids transfer of phosphatidylserine (PS) which is primarily synthesised in the endoplasmic reticulum (ER). Mitofusin 2 extracts PS into membranes allowing transfer of PS to mitochondria where PS is converted to phosphatidylethanolamine (PE) to be sent to ER for making phosphatidylcholine. A deficiency in Mitofusin 2 causes reduction in transfer of PS from ER to mitochondria impairing lipid metabolism. This defective transfer leads to

ER stress and causes NASH-like symptoms and cancer. It was clear that hepatic Mitofusin 2 gets downregulated in human liver during progression from simple steatosis to NASH. The study describes a novel function of Mitofusin 2 in maintenance of phospholipid metabolism. The link between Mitofusin 2 and phospholipids is particularly important because this can influence antioxidant, anti-inflammatory, anti-fibrotic properties and several membrane dependent functions. Re-expression of Mitofusin 2 in mice on chow diet improved the liver disease.

The current study describes a novel previously unreported mechanism for development of non-alcoholic fatty liver disease and highlights Mitofusin 2 protein as a possible new therapeutic target for treating non-alcoholic fatty liver disease. Future studies shall focus on various approaches which could enhance the levels of Mitofusin 2 without causing side effects.

Source(s)

Hernández-Alvarez MI. 2019. Deficient Endoplasmic Reticulum-Mitochondrial Phosphatidylserine Transfer Causes Liver Disease. Cell, 177 (4). DOI: 10.1016/j.cell.2019.04.010 ■

Gene Therapy for *Heart Attack (Myocardial Infarction): Study on Pigs Improved* Cardiac Function

For the first time, delivery of genetic material induced heart cells to de-differentiate and proliferate in a large-animal model after myocardial infarction. This led to improvement in heart functions

According to WHO, around 25 million people worldwide are affected by heart attacks. A heart attack - called myocardial infarction - is caused by a sudden blockage of one of the cardiac coronary arteries. Heart attack causes permanent structural damage to the heart of the surviving patient through scar formation and the organ is unable to overcome loss of cardiac muscles. This can frequently lead to heart failure and even death. A mammal's heart can only regenerate itself immediately after birth unlike fish and salamander who have the ability to regenerate their heart lifelong. Cardiac muscle cells or cardiomyocytes in humans are henceforth unable to replicate and regenerate lost tissue. Stem cell therapy has been tried to regenerate heart in a large animal but with no success so far.

It has been established before that new tissue could form in the heart by de-differentiation of already existing cardiomyocytes and cardiomyocytes proliferation. Limited levels of cardio-

myocyte proliferation have been seen in adult mammals including humans thus enhancing this property is seen as a potential way to achieve cardiac repair.

Previous studies in mice have shown that cardiomyocyte proliferation can be controlled by genetic manipulation therapy via microRNAs (miRNAs) by utilizing the understanding of cardiomyocyte maturation process. MicroRNAs - small non-coding RNA molecules - regulate gene expression in various biological processes. Gene therapy is an experimental technique which involves introduction of genetic material into cells to compensate for abnormal genes or to enable expression of a crucial protein(s) in order to treat or prevent a disease. The genetic material cargo is delivered by using viral vectors or carriers as they can infect the cell. Adeno-associated viruses are generally used as they have higher efficiency and capability plus, they are safe for long-term use because they do not cause a disease in humans. Previous gene therapy study in mouse model has shown that some human miRNAs can stimulate cardiac regeneration in mice after myocardial infraction.

In a new study published in *Nature* researchers describe gene therapy which can induce heart cells to heal and regenerate after a heart attack for the first time in a clinically relevant large-animal model of pig. Post myocardial infarction in pigs, researchers delivered a small piece of genetic material microRNA-199a into heart of pigs through direct injection into myocardial tissue using adeno-associated 6. Results showed that car

diac function in pigs viral vector AAV Serotype was completely repaired and recovered from myocardial infarction after a period of one month compared to the control group. A total of 25 treated animals showed significant improvements in contractile function, increased muscle mass and diminished cardiac fibrosis. Scars were reduced in size by 50 percent. Known targets of miRNA-199a were seen to be downregulated in the treated animals including two factors of the Hippo pathway which is an important regulator of organ size and growth and performs roles in cell proliferation, apoptosis and differentiation. The spread of miRNA-199a was restricted only to the injected cardiac muscle. Imaging was done using cardiac magnetic resonance imaging (cMRI), utilizing late gadolinium enhancement (LGE) – LGE (cMRI).

The study points at the importance of careful dosage in this particular gene therapy. Long term, persistent and uncontrolled expression of the microRNA caused sudden arrhythmic death of majority of the pig subjects who were being treated. Thus, design and delivery of artificial miRNA mimics is required as virus-mediated gene transfer may not be able to achieve the desired purpose effectively.

The current study shows that delivering effective 'genetic drug' can induce cardiomyocyte de-differentiation and proliferation thus stimulating cardiac repair in a large-animal model – here pig which has heart anatomy and physiology similar to humans. The dosage would be of critical importance. The study reinforces the appeal of miRNAs as genetic tools because of their ability to regulate and control levels of several genes at the same time. The study will soon move to clinical trials. Using this therapy, new and effective treatments could be developed for severe cardiovascular diseases.

Source(s)

1. Gabisonia K. 2019. MicroRNA therapy stimulates uncontrolled cardiac repair after myocardial infarction in pigs. Nature. DOI: 10.1038/s41586-019-1191-6

2. Eulalio A. 2012. Functional screening identifies miRNAs inducing cardiac regeneration. Nature. 492. DOI: 10.1038/nature11739 ■

Advancement in *Harnessing Solar Energy to Generate* Power

Study describes a novel all-perovskite tandem solar cell which has the potential to provide inexpensive and more efficient way to harness Sun's energy to generate electrical power

Our reliance on non-renewable source of energy called fossil fuels such as coal, oil, gas has had a tremendous negative impact on mankind and environment. Burning of fossil fuels adds to the greenhouse effect and effect and causes global warming, destroys habitats, causes air, water and land pollution and affects public health. There is an urgent need to build sustainable technology which can help to power the world using clean energy. Solar energy technology is one such method which has the capability to harness Sun's light – the most abundant renewable source of energy - and convert it into electrical energy or power. The advantageous factors of solar energy in terms of benefitting humans and environment have played a key role in promoting use of solar energy.

Silicon is the commonly used material to make solar cells in solar panels that are available in the market today. The photovoltaic process of solar cells can transform sunlight into electricity without additional use of any fuel. Design and efficiency of silicon solar panels has significantly improved over decades due to advancements in manufacturing and technology. The photovoltaic efficiency of a solar cell is defined as the portion of the energy which is in the form of sunlight and which can be converted into electricity.

taic efficiency and overall costs are the two main limiting factors in solar panels today.

Apart from silicon solar cells, tandem solar cells are also available in which specific cells are used which are optimized for every section of the Sun's spectrum thereby leading to increase in overall efficiency. A material called perovskites is considered better than silicon in absorbing high-energy blue photons from sunlight i.e. another part of the Sun's spectrum. Perovskites are polycrystalline material (generally methylammonium lead trihalide (CH3NH3PbX3, where X is iodine, bromine or chlorine atom). Perovskites are easy to process into sunlight-absorbing layers. Earlier studies have combined silicon and perovskites into solar cells i.e. having silicon cells on the top which can absorb yellow, red and near infrared photons along with perovskite cells thus almost doubling the production of power.

In a new study published in *Science* researchers have for the first time developed all perovskites tandem solar cells which give efficiency of up to 25 percent. This material is called lead-tin mixed low-band gap perovskite film ((FASnI3)0.6 MAPbI3)0.4; FA for formamidinium and MA for methylammonium). Tin has the disadvantage of reacting with oxygen from air creating defects in the crystalline lattice which can disrupt movement of electrical charge in the solar cell thereby limiting

limiting cell's efficiency. Researchers found a way to prevent tin in perovskite from reacting with oxygen. They used a chemical compound called guanidinium thiocyanate to significantly improve structural and optoelectronic properties of lead-tin mixed low-band gap perovskite films. The compound guanidinium thiocyanate coats perovskite crystallites in the solar absorbing film thus preventing oxygen from going inside to react with tin. This straightaway enhances efficiency of the solar cell from 18 to 20 percent. Also, when this new material was combined with conventionally used high-absorbing top perovskite layer, the efficiency further increased to 25 percent.

Key points

- Solar energy technology has the capability to harness Sun's light and convert it into electrical energy or power.
- Tandem solar cells which use all perovskite thin-films have been designed.
- The new material is of high quality, is inexpensive and its fabrication is simpler while cost is low compared to silicon and silicon-perovskites tandem cells.

The current study describes for the first time design of tandem solar cells using all perovskite thin-films and this technology could one day replace silicon in solar cells. The new material is of high quality, is inexpensive and its fabrication is simpler while cost is low compared to silicon and silicon-perovskites tandem cells. Perovskites are man-made material compared to silicon and perovskites based solar panels are flexible, lightweight, and semi-transparent. Although the current material will take some time to surpass efficiency of silicon-perovskite technology. Nevertheless, perovskite-based polycrystalline films have the potential for designing tandem solar cells which could provide efficiency of up to 30percent while keeping other factors unhindered. Further studies are needed to make the material robust, more stable and also recyclable to reduce impact on environment. Solar energy sector is one of the fastest growing and the ultimate goal is to discover a promising alternative for clean energy.

Source(s)

Tong J. 2019 Carrier lifetimes of >1 μs in Sn-Pb perovskites enable efficient all-perovskite tandem solar cells. Science, 364 (6439).
DOI: 10.1126/science.aav7911 ■

Treating Cancer Through Restoring *Function of Tumour Suppressor* Using Vegetable Extract

Study in mice and human cells describes reactivation of an important tumour suppressive gene using a vegetable extract thus offering a promising strategy for cancer treatment

Cancer is the second leading cause of deaths worldwide. In cancer, multiple genetic and epigenetic alterations are either inherited or somatically acquired. These alterations involved in cancer development are of two distinct types – (a) activation or 'gain in function' of cellular oncogenes and (b) inactivation or 'loss of function' of tumour suppressor genes. Tumour suppressor genes typically inhibit cell proliferation and tumour development. If they get deactivated, negative regulators of cell proliferation are lost and this contributes to abnormal proliferation of tumour cells. Reactivation of tumour suppressors as a potential strategy for treatment of human cancers has been researched but not explored in as much detail as inhibition studies of oncogenic proteins.

A potent tumour suppressive gene called PTEN is the most commonly mutated, deleted, down-regulated or silenced gene in human cancers. PTEN is a phosphatase which is active as a dimer at the plasma membrane. If PTEN mutations are inherited then it can cause syndromes like susceptibility to cancer and developmental defects. Tumour cells exhibit low levels of PTEN. Restoration of normal levels of PTEN in cancer cells can allow PTEN gene to continue its tumour suppressive activity. It is known that PTEN dimer formation and its recruitment at the membrane is critical for its function, however, the exact molecular mechanisms of this are still unknown.

A study published in *Science* describes a new pathway involving PTEN which acts as a regulator for tumour growth control and is important for development of cancer. Researchers studied a

gene called WWP1 which is known to play an important role in development of cancer and produces an enzyme ubiquitin E3 ligase. This enzyme is a PTEN interacting protein which inhibits tumour suppressive activity of PTEN by suppressing PTEN's dimerization, membrane recruitment and thereby its functions. WWP1 is genetically augmented in many cancers including breast, prostate and liver. After exploring this enzyme's 3-dimensional structure, researchers shortlisted a small molecule called indole-3-carbinol (I3C) which could inhibit the activity of this enzyme. I3C, a natural compound, is an ingredient of broccoli and other cruciferous vegetables which include cauliflower, cabbage, kale and brussels sprouts. It is well known that such vegetables are healthy additions to one's diet and also their consumption has been previously linked to decreased risk of cancer. The compound I3C was administered to cancer prone mice (mouse model of prostate cancer) and into

human cell lines and it was seen that I3C inhibited activity of WWP1 by depleting it. This led to restored tumour suppressive power of PTEN. I3C is thus a natural pharmacological inhibitor of WWP1 which can trigger PTEN reactivation. WWP1 appeared to be a direct MYC target gene (protooncogene) for MYC driven tumorigenesis or formation of tumours. The study showed that perturbation of WWP1 is enough to restore PTEN's tumour suppression activity.

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Source(s)

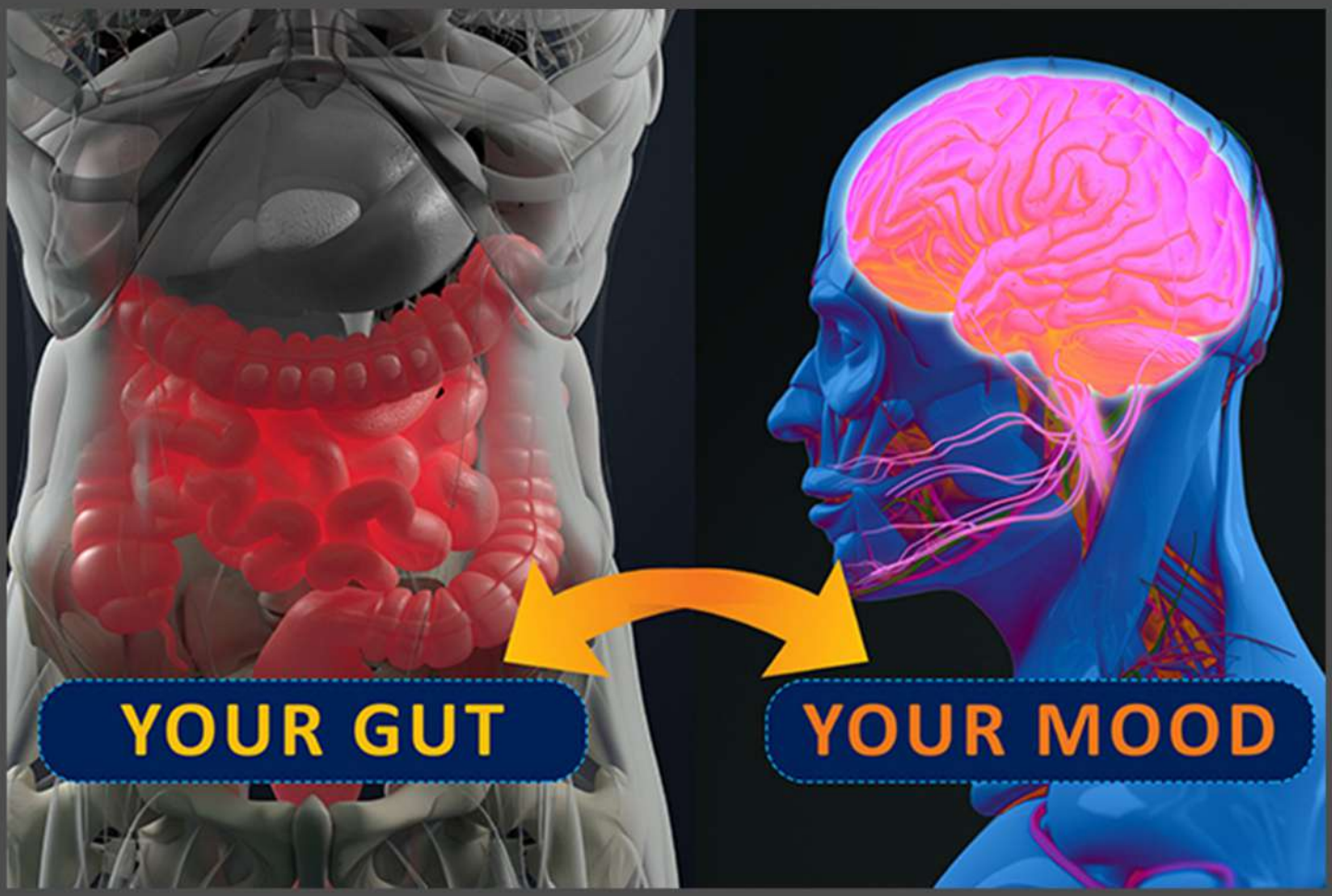
Lee Y. 2019. Reactivation of PTEN tumor suppressor for cancer treatment through inhibition of a MYC-WWP1 inhibitory pathway. Science, 364 (6441).
DOI: 10.1126/science.aau0159 ■

Anxiety Relief *Through Probiotic and Non-Probiotic* Diet Adjustments

A systematic review provides comprehensive evidence that regulating microbiota in intestine could be a possible approach to relieve symptoms of anxiety

Our gut microbiota – trillions of natural microorganisms in the gut– are known to perform important roles in immunity, metabolism and mental health. Several studies have shown that gut microorganisms can also regulate mechanisms. Anxiety - the intense, excessive and persistent worry and fear of events or situations - is common in mental disorders and many physical disorders when stress is involved. Symptoms of anxiety include feeling nervous, tense, increased heart rate and breathing, sweating, insomnia etc. Microbial imbalance of intestinal microbiota has been linked to anxiety though direct evidence of improvement in anxiety symptoms by regulating this microbiota has not been available.

In a new systematic review published in *BMJ General Psychiatry* a team of researchers exclusively reviewed randomized controlled trials on humans published in the past with an aim to investigate evidence that anxiety symptoms could be improved by regulating microorganisms in the intestine. They screened past literature and retrieved 3334 articles from five English and four Chinese databases and shortlisted 21 studies. A systematic evaluation of a total of 21 studies which had collectively analyzed around 1500 individuals was then conducted. The subjects had anxiety symptoms measured on anxiety scales irrespective of their diagnosis. All studies used interventions to regulate intestinal microbiota (IRIFs) which included probiotic supplements or diet alteration. 14 of these studies used probiotics as interventions while remaining used alteration in one's daily diet. Probiotics are food



supplements which contain "good" bacteria that can fight against "harmful" bacteria and perhaps do not allow them to settle in the gut. Alternatively, eating a plant-based diet rich in fiber can increase good bacteria in the gut. The outcome of every study was evaluated by measuring anxiety symptoms using standardized anxiety assessment scales.

Analysis showed that in 11 studies out of 21, an alleviating effect was seen on anxiety symptoms due to regulation of intestinal microbiota indicating effectiveness in almost 52 percent of studies. In 14 studies which used probiotics supplements as intervention, 36 percent studies found regulation to be an effective tool in reducing symptoms. Finally, in 6 out of 7 studies which used non-probiotics interventions, effectiveness was seen to be 86 percent. In 5 studies which used IRIF interventions approach along with regular treatment, only the studies using non-probiotics interventions got positive results indicating that non-probiotic interventions along with IRIF was more effective than IRIF alone. Altering one's diet may have higher impact on gut bacteria compared to addition of

Key points

- Studies have shown that gut micro-organisms can also regulate brain mechanisms.
- Systematic review shows that in at least half of the studies modulation of microbiota in intestine could treat anxiety symptoms in patients irrespective of the diagnosis.
- Probiotic or non-probiotic interventions could be possibly used to treat anxiety.

specific types of bacteria consumed through a probiotic supplement. No adverse events were reported in most studies, only mild dry mouth, discomfort or diarrhea.

At least half of the studies evaluated showed that modulating microbiota in intestine could treat anxiety symptoms in patients irrespective of the diagnosis. And, a non-probiotics approach by making suitable diet adjustments was more effective compared to probiotic interventions. For clinical treatment of anxiety, psychiatric drugs are used. Alternatively, when patients are not suitable to recieve such drugs - especially when they have somatic diseases – probiotic or non-probiotic interventions could be possibly used to treat anxiety.

Source(s)

Yang B. 2019. Effects of regulating intestinal microbiota on anxiety symptoms: A systematic review. General Psychiatry.
DOI: 10.1136/gpsych-2019-100056 ■

The Challenge of Safe Drinking Water: A Novel Solar Powered Home-based, Low Cost Water Purification System

Study describes a novel portable solar-steaming collection system with polymer origami which can collect and purify water at a very low cost

There is an increasing global demand for clean water owing to population growth, industrialization and contamination and depletion of our planet's natural resources. Solar-steaming is a technique in which solar energy can be used to purify water by evaporating contaminated water, re condensing it and producing fresh clean water. This technique is a clean, renewable and sustainable green technology which has the potential to address global scarcity of clean water by utilizing the abundance of solar energy. The strength and efficiency of a solar-steaming system depends on its design and choice of photothermal materials. Current solar-steaming technologies use expensive, bulky materials and have low efficiency and limited output. It has remained a challenge to enhance performance and lower costs in order to design a light weight and portable solar-steaming system which can be directly used by individuals.

In a new study published in *Advanced Materials* researchers describe a novel method for solar steaming by designing a low cost portable low-pressure controlled solar steaming collection system which can collect and purify water using energy from sunlight. They chose a photothermal polymer material called Polypyrrole (PPy) which is conductive in nature, is well-known for its photothermal properties and exhibits high efficiency in converting solar light into thermal heat. Inspired from the flower rose, the unique design of this solar steaming system is made of 3D origami PPy-paper composites.

SAFE DRINKING WATER

HOME-BASED LOW COST WATER PURIFIER

A 'PPy rose' which constitutes of layered black sheets shaped as petals was created via origami folding and chemical polymerization of PPy. This origami structure is attached to a stem-like cotton infused tube which collects raw/untreated water from a water source and feeds it to the PPy rose structure placed on the top. Cotton infused tube and Polystyrene foam were used to prevent direct contact between PPy material and bulk water. nce untreated water reached the petals, PPy material in the flower structure turns water into steam and impurities naturally separate from the water. Subsequently, the water vapor needs to be condensed and then clean water needs to collected for use. Researchers used a low-pressure condition by using a portable vacuum pump. This was seen to significantly enhance the rates of both water evaporation and water collection. Once water is condensed, the compact and sturdy collecting glass jar securely stores clean water.

The 3D origamis provided significantly higher absorption of light and enhanced surface areas for

water evaporation in comparison to a conventional 2D planar design. The water evaporation and collection rate is enhanced by 52 percent due to lowering of chamber pressure. PPy origami improved water evaporation by 71 percent and higher steam collection rates were also seen. The overall efficiency of the system increased by 91.5 percent under one light source. The system was tested on a sample from Colorado river in Texas, USA. The system removed contamination of water in the form of heavy metals, bacteria, salt and alleviates alkalinity producing clean water of drinking standards as set by WHO.

The current study describes a novel rational design of a portable low-cost solar-steaming collection system with 3D origami photothermal materials which offers improved rates of water evaporation and steam collection. The cost of each flower-like structure is less than 2 cents and it can successfully produce 2 liters of clean water per hour per square meter. This design can be an inspiration to fabricate unique models of solar-steaming for clean water production.

Source(s)

Li, W. 2019. Portable Low-Pressure Solar Steaming-Collection Unisystem with Polypyrrole Origamis. Advanced Materials.
DOI: 10.1002/adma.201900720

Consumption of *Highly Processed Foods and Health: New Evidences* from Research

Two studies provide evidences that associate high consumption of ultra-processed food with increased health risks

The food that we consume regularly has long term effects on our health. One way of classifying food items is by their level of industrial processing. Foods like fresh fruits and vegetables, milk, legumes, grains, eggs are unprocessed or minimally processed. "Processed" foods like cheese, some breads, canned fruits and vegetables etc generally contain added salt, oil, sugar etc. In contrast, highly processed or "ultra-processed" food items have been through extensive industrial processing to either improve taste or increase their shelf life. Ultra-processed foods are thus chemical-laden with added preservatives, sweeteners or color enhancers. Such foods are highly addictive and they contain high levels of added sugar, fat and/or salt and lack in vitamins and fibers.

Examples of ultra-processed foods include junk food, packaged baked goods, fizzy drinks, processed meat, breakfast cereals having high sugar, instant soups, readymade meals etc. and they are sold in boxes, cans, jars or bags.

Experts comment that if the ingredient list of a food is more than five items then it is definitely in ultra-processed category. Consumption of ultra-processed foods is high in many developed countries because of their culinary appeal, price, availability and longer shelf life. Many studies have linked such ultra-processed foods to increased risk of obesity, high blood pressure, high cholesterol but evidence has remained limited.

Two new studies published in *BMJ* provide strong evidences which point towards a positive link between consuming highly processed foods and increased risk of cardiovascular diseases and death. In the first large cohort study researchers collected data of 105,159 French adults of both genders and average age of 43 years. As part of NutriNet-Sante study, participants had completed an average of six 24-hour dietary questionnaires to measure their usual intake of 3,300 food items grouped according to grade of processing based upon NOVA classification.

The rates of diseases of these adults was measured over a follow-up period of 10 years. Results showed that 10 percent increase in ultra-processed foods consumption was associated with increased rates of cardiovascular diseases and coronary heart diseases. And, strong association was found between fresh or very minimally processed foods and lower risk of these diseases. Researchers next aim to add all commercial brand names of various industrial products in the participant's dietary records in order to more accurately evaluate the exposure.

In a second study, participants - 18,899 Spanish male and female adults of average age of 38 years - completed 136-food item questionnaire every other year between 1999 and 2014 as part of SUN (Seguimiento Universidad de Navarra) study. Similar to the first study, food items were grouped based upon levels of processing. Results indicated that higher intake of ultra-processed food (i.e. more than 4 servings in a day) was linked to 62 percent increased risk of mortality (due to any cause) compared to consumption of 2 servings a day. With every extra serving of ultra-processed

food, mortality risk went up by 18 percent. Both studies took into account established lifestyle factors and markers of dietary quality.

Consumption of ultra-processed food in developed countries is alarmingly high and thus it is imperative to inform consumers about health implications so that they can make informed choices. Appropriate nutritional guidelines, product reformulations to improve nutritional quality and suitable taxations are needed to discourage consumers and limit consumption of ultra-processed food items. Fresh or minimally processed foods must be endorsed and on the other hand marketing of ultra-processed foods must be restricted. This needs to be implemented in health policies particularly in developed countries.

Source(s)

1. Srour B, 2019. Ultra-processed food intake and risk of cardiovascular disease: prospective cohort study (NutriNet-Santé). BMJ. DOI: 10.1136/bmj.l1451

2. Rico-Campà A. 2019. Association between consumption of ultra-processed foods and all cause mortality: SUN prospective cohort study. BMJ. DOI: 10.1136/bmj.l1949

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New Understanding *of Mechanism of Tissue Regeneration Following Radiation* Therapy

Animal study describes role of URI protein in tissue regeneration after exposure to high-dose radiation from radiation therapy

Radiation Therapy or Radiotherapy is an effective technique for killing cancer in the body and is majorly responsible for boosting cancer survival rates in the past decades. However, one of the main disadvantages of intensive radiotherapy is that it simultaneously damages healthy cells in the body - particularly vulnerable healthy intestinal cells - in patients undergoing treatment for liver, pancreas, prostrate or colon cancer. This toxicity and tissue damage caused by high-dose ionizing radiation is generally reversed after radiotherapy treatment is complete, however, in many patients it leads to complications like lethal disorder called gastrointestinal syndrome (GIS). This disorder can kill intestinal cells, thereby destroying the intestine and leading to patient's death. No treatments are available for GIS except alleviating its symptoms like nausea, diarrhea, bleeding, vomiting etc.

In a new study published in *Science* researchers aimed to understand the events and mechanisms of GIS after radiation exposure in an animal model (here, mouse) to identify biomarkers which can predict the levels of intestinal toxicity after the animal has been exposed to severe radiation. They focused on the role of a molecular chaperone protein called URI (unconventional prefoldin RPB5 interactor), whose exact function is still not fully understood. In an earlier in *vitro* study by the same group, high URI levels were seen to provide protection to intestinal cells from DNA damage caused by radiation exposure.

In the current study conducted in vivo, three GIS genetic mouse models were developed. First model had high levels of URI expressed in the intestine. In the second model URI gene in the intestinal epithelium were deleted and third model was set as control. All three groups of mice were exposed to high doses of radiation of more than 10 Gy. Analysis showed that up to 70 percent of mice in the control group died due to GIS and all mice who had the URI protein gene deleted also died. But all mice who were in the group who had high levels of URI survived the high-dose radiation exposure.

When URI protein is highly expressed, it specifically inhibits β-catenin which is essential for tissue/organ regeneration after irradiation and thus cells do not proliferate. Since radiation damage can only be inflicted on cells which are proliferating, no effect is seen on the cells. On the other hand, when URI protein is not expressed, reduction in URI activates β-catenin–induced c-MYC expression (oncogene) causing cell proliferation and increasing their susceptibility to radiation damage. Therefore, URI plays a key role in promoting tissue regeneration in response to high-dose irradiation.

Key points

- Radiation Therapy is an effective technique for killing cancer in the body.
- Intensive radiotherapy is that it simultaneously damages healthy cells in the body.
- Study explores mechanisms involved in tissue regeneration post irradiation which can help in developing methods to possibly get protection from high-dose radiation following radiotherapy.

This new understanding of the mechanisms involved in tissue regeneration post irradiation can help in developing novel methods to possibly get protection from high-dose radiation following radiotherapy. The study has implications for cancer patients, victims of accidents involving nuclear plants and astronauts.

Source(s)

Chaves-Pérez A. 2019. URI is required to maintain intestinal architecture during ionizing radiation. Science. 364 (6443).
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