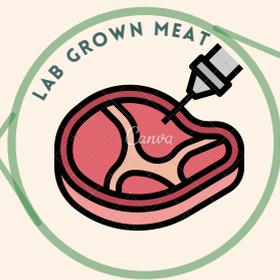
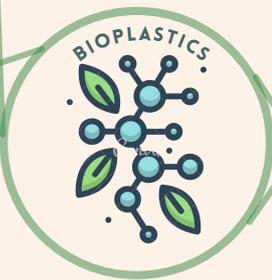
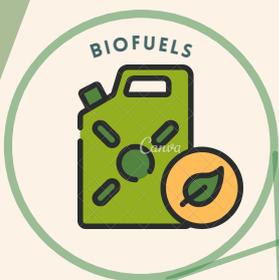




FEATURE ARTICLE ON

# SUSTAINABILITY AND BIOTECHNOLOGY



# BIOGENESIS

THE OFFICIAL NEWSLETTER OF BIOGENEAIAC ASSOCIATION  
MOUNT CARMEL COLLEGE

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# The Horrors of Palm Oils and Future Prospects

MEENA LALITHA CHANDAR | BTCB 3RD YEAR



Orangutans

Credits: [www.thegreatprojects.com](http://www.thegreatprojects.com)



Eka 1 and Eka 2 seeds

Credits: [www.ideaspies.com](http://www.ideaspies.com)

## INTRODUCTION

Palm oil is a hidden evil laced within practically all products we buy. The deforestation and unholy working conditions of labourers (akin to slavery) has scourged the earth. Our unique primate relatives, the **orangutans** are especially threatened by this and **are being driven to extinction due to habitat loss**. The deforestation is also a leading cause of climate change.

The solution to this problem would be to avoid palm oil and it is **essential that we make an effort** to. However, the reality is that industries will relentlessly use it. So, let us understand why palm oil is a popular choice in the first place.

Palm oil has a multitude of valuable properties- it is semi-solid at room temperature, it is resistant to oxidation so can give products a longer shelf-life; it's stable at high temperatures, and it's also odourless and colourless so doesn't alter the look or smell of food products (unlike coconut oil).

Palm oil can also be extracted with much higher yield than other oils and is not affected by seasons. It is also cost effective.

## BIOTECH AS A SOLUTION

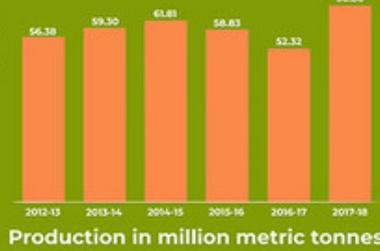
In order to make palm oil more sustainable, Golden-Agri Resources have developed new seeds, known as Eka 1 and Eka 2. They could produce up to three times as much of oil than the average. The modified seeds would also mature faster, and would be less susceptible to drought and disease.

These seeds were produced through tissue culture and conventional selection. These seeds are non-GMO. This could be the key to more sustainable palm oil due to less land requirement.

The quandary that we face is whether to continue using palm oil. Indonesia's economy is largely dependent on this industry and other oils are not as efficient. There have been efforts to certify that the palm oil is obtained sustainably (called **RSPO**). However, the truth is that this claim is nebulous and that we cannot predict the accuracy of the statement.

## THE FACTS

Indonesia is the world's largest producer of palm oil, producing over **27 million tonnes of palm oil** per year.



As well as being the main export of palm oil, Indonesia is home to both Borneo and Sumatra - the only places to see **orangutans in the wild.**



The financial viability of palm oil is obvious, with the oil being found in

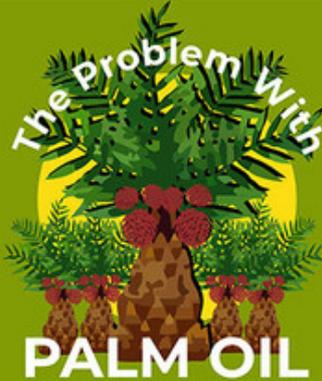


**50%** of all supermarket foods - but at what cost?

## THE PROBLEM



Only half of Borneo's forest cover remains today, down from 75 per cent in the mid 1980s. This means in Borneo and Sumatra combined, orangutans have lost 80% of their habitat.



Over **50,000** orangutans on the islands of Borneo and Sumatra have died



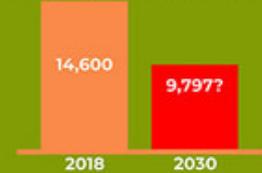
because of deforestation linked to palm oil production.

## THE FUTURE



This is a huge contribution to the climate change problem. As the planet temperature rises, both humans and animals will suffer irreversible consequences to their habitats, food sources and health.

By 2030, Sumatran orangutan populations are expected to plummet by **32.8%**



*thegreatProjects*

Credits: [www.thegreatprojects.com](http://www.thegreatprojects.com)

## WHAT CAN WE DO TO HELP?

- Reduce our demand by buying less processed foods
- Boycott in the right places- Targeting the larger consumers will help.
- Create awareness of the issue

## "UNITED WE STAND, DIVIDED WE FALL"

This proverb holds much truth to it. Only if we all stand together and fight for a change, there would be a chance to have a better future for every being. Let us be the spark that ignites the flame of pro-action.

# Fungal Biotechnology for Agricultural Sustainability

SREEPRIYA | BTCZ 3RD YEAR

## INTRODUCTION

The world's growing population has posed a serious challenge to food security. According to projections, India would be the world's most populated country by 2050 China will be the second-largest country in the world by 2050 (2001, Population Reference Bureau). Growth in the population, Will this be the case, especially in underdeveloped countries? As a result, a 70% increase in food production will be required. By 2050, great progress will have been made. In the coming years, agricultural production will be improved a focus for several decades. As a result, the population is becoming increasingly frightening. Our country's main worry is the increase. This is a huge problem. Traditional agricultural practices face a problem because agricultural machinery. In order to increase agricultural output, current methods and practices are nearing their limitations of efficacy.

## FUNGAL BIOTECHNOLOGY AS A SOLUTION

In this regard, biotechnology has focused its efforts on developing technologies that can boost crop yields. Fungal biotechnology has opened up new possibilities for utilizing beneficial fungal communities that produce bioactive compounds and secondary metabolites that are beneficial to agriculture and related industries' long-term sustainability.

Beneficial **agriculturally important fungi (AIF)** can be used for plant growth promotion and protection from phytopathogenic organisms via various PGP mechanisms because they have multifunctional **plant growth-promoting (PGP)** attributes. Metabolic engineering and fungi synthetic biology also aid in the characterization of various groups of potential bioactive compounds and secondary metabolites for long-term sustainability.

Microbes are also important in the long-term sustainability of food agriculture and human health. For their long-term usage in agriculture, fungal microbes are utilised as biofertilizers, natural fermentators, biopesticides, and bioherbicides, among other things.

**Fungal protein**, such as some highly nutritional mushrooms like *Calocybe indica* (Milk mushroom), *Cordyceps sinensis* (Insect mushroom, Kirajali), *Lentinula edodes* (Shiitake), which are pharmaceutically important with many types of bioactive



**Mushroom mycelium for the decomposition of organic matter**  
Credits: [www.brittanica.com](http://www.brittanica.com)



*Calocybe indica*, 'Milky White Mushroom', edible, rich in protein

Credits: [www.mycelia.be.com](http://www.mycelia.be.com)

compounds of medicinal importance, contributes to the production of healthy and nutritious foods.

**Biotechnology has aided in the development of sustainable agriculture in the following ways:**

1. Resistance to biotic stressors (insect pests and illnesses)
2. Increased abiotic stress resistance (drought, cold, floods, and soil problems);
3. Polluted soil bioremediation and pollution monitoring using bio detectors
4. Productivity and quality improvements.
5. Increased nitrogen fixation and nutrient absorption and utilization efficiency.
6. Fermentation technology that is more advanced.

7. Improved biomass-derived energy generation technology.

8. High-nutrient production in nutrient-deficient staple crops such as rice.

Plant development and production are aided by beneficial fungus. The formation of innovative multipartite endo- and ecto-symbiotic communities based on extensive genetic and molecular (metagenomic) investigations might be a key component of agricultural microbiology's future growth.

The most common method for doing so is to make composite inoculants that mimic natural plant-associated microbial populations. For the purpose of balancing. The combination of N- and P-providing symbionts, including endosymbiotic rhizobia + VAM-fungi, would appear to be promising for the host plant metabolism.

Finally, the use of biotechnological tools and microbiological techniques has opened new vistas in the field of sustainable development, notably in the fields of medicine, agriculture, silviculture, horticulture, the environment, and other critical challenges.

# Enzymatic Detergents

TANISHA GAYON | BTCZ 2ND YEAR

## INTRODUCTION

Enzymatic cleaners contain enzymes, which help to break down soils at a neutral pH (typically pH 6-8). Types of enzymatic cleaners include proteases, amylases, and lipases which break down various types of soils. All types of enzymes belong to the class of compounds called proteins. An enzymatic cleaner is used in healthcare facilities to aid in cleaning and decontamination of medical equipment and utensils.

## BENEFITS OF USING ENZYMATIC CLEANERS

- Assisting in the removal and break down of organic soils at neutral pH
- Reducing bioburden
- Cleaning with limited mechanical action in hard to reach areas
- Offering a broader range of material compatibility than alkaline chemistries, for delicate instruments
- Effective at low concentrations and lower temperature than detergents, allowing for smaller, more ergonomic packaging.

## ENZYMATIC CLEANERS DURING DECOMBINATION OF MEDICAL DEVICES

After an instrument or an endoscope is transported to the processing area, it first undergoes manual cleaning, which ideally includes pre-soak, clean and rinse phases. If the medical devices require ultrasonic washing, an enzymatic washing is used during the cleaning cycle. After the initial pre-wash phase used



Credits: [www.medalkan.com](http://www.medalkan.com)

for gross soil removal, an enzymatic detergent is typically used in the first wash phase to break down remaining adherent soils. The second phase typically utilizes a neutral/alkaline detergent, which further breaks down organic and inorganic soils and is followed by a rinse.

## OPTIMIZING THE EFFECTIVENESS OF ENZYMATIC CLEANERS

These factors include:

- Amount and type of soil- the type of soil may be blood, serum, tissue, etc.
- Ease of use- Enzymes perform well with less mechanical action
- Temperature- the optimal range for use of protease enzymes is between 100-300°F
- pH Level- The cleaning environment is determined by the type of water used during cleaning, the product pH and the soil itself, but most enzymatic products work best to balance good activity with materials compatibility between the pH range of 6-8.

# BIOPLASTICS

RAKSHITHA B R | BTCZ 2ND YEAR

## WHAT ARE BIOPLASTICS?

Bioplastics are biodegradable materials that come from renewable sources and can be used to reduce the problem of plastic waste that is suffocating the planet and contaminating the environment.

Bioplastics are mostly made of carbohydrate-rich plants such as corn, sugar cane or sugar beet – so-called food crops or first generation feedstock. First generation feedstock is currently the most efficient for the production of bioplastics, as it requires the least amount of land to grow and produces the highest yields.

## PLASTICS AND POLLUTION

Recycling is groundwork of the worldwide efforts to diminish the amount of plastics in waste. Mostly around 7.8–8.2 million tons of poorly-used plastics enter the oceans every year. Non-biodegradable plastics settlements in landfills are uncertain, which hinders the production of land resources. Non-biodegradable plastic solid wastes, carbon dioxide, greenhouse gases, various air pollutants, cancerous polycyclic aromatic hydrocarbons and dioxins, released to the environment cause severe damage and harmfulness to the inhabitants. Due to the bio-degradability and renewability of biopolymers, petroleum-based plastics can be replaced with bio-based polymers in order to minimize the environmental risks.

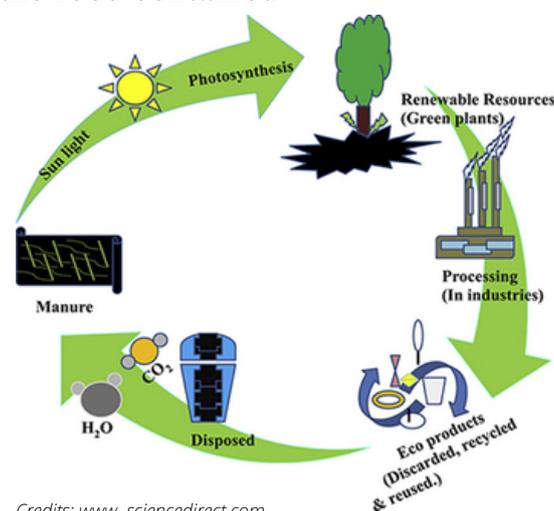
## BIOPLASTICS AS A SOLUTION

Bioplastics make it possible to develop

innovative, alternative solutions compared to conventional plastics. Even more, biobased plastics reduce dependence on fossil resources whilst improving a product's carbon footprint. Biodegradable plastics allow enhanced end-of-life scenarios for disposal and recycling. This may lessen the burden on our existing waste systems and also the environment. The packaging industry is currently the largest user of bioplastics, but there are many other suitable applications possible, and consumers are increasingly interested in alternative bio solutions.

### Advantages of bioplastics

- They reduce carbon footprint
- They providing energy savings in production
- They do not involve the consumption of non-renewable raw materials
- Their production reduces non-biodegradable waste that contaminates the environment
- They do not contain additives that are harmful to health, such as phthalates or bisphenol A
- They do not change the flavor or scent of the food contained



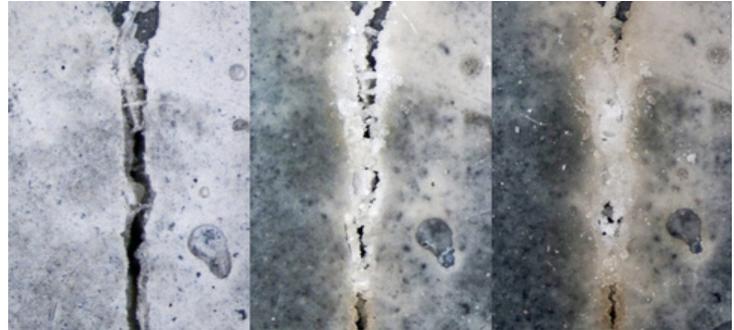
Credits: [www.sciencedirect.com](http://www.sciencedirect.com)

# Self-Healing Concrete

ANYA VACHA | BTCZ 2ND YEAR

Biomaterials have been used in buildings since humans began making huts out of wood and mud, but it's only the waves of environmental consciousness that occurred in the past decade that have brought biomaterials into the modern construction industry. With more companies looking into sustainability, the demand for biomaterials has begun to rise in an industry where there is an essential, cheap and efficient staple: concrete. A mix of cement, sand and other aggregates, it is widely produced via a process that is highly polluting especially from the mining to the burning of the limestone in the cement and the manufacture of cement around the globe is ~5% of CO2 emissions. In fact, a single ton of cement yields a minimum of half a ton of carbon dioxide.

The widespread use of cement in an increasingly eco-friendly world resulted in the creation of better alternatives that help in different ways. Concrete is notorious for its affinity to crack despite its strength and its usual steel reinforcements, which is an added consequence because it is expensive in terms of carbon footprint, money and time to repair. Due to the formation of micro-cracks, water, carbon dioxide and chlorine ions are able to enter into the concrete and degrade the inner reinforcements as well as the cement itself. In an effort to reduce the amount of pollution caused by its use, its demand needed to be lowered, so it's life span was increased by creating self-healing concrete because it is virtually impossible to stop the formation of cracks.



Credits: [www.certifiedenergy.com](http://www.certifiedenergy.com)

In order to achieve the “healing”, the concrete needed to be brought alive using synthetic biology and microbiology. A 3 year research project named Materials for Life based out of the University of Bath, Cambridge and Cardiff resulted in the the first UK site trial of self-healing concrete. Researchers from the University of Bath used three species of *Bacillus* bacteria which produce calcite crystals, which are an important form of calcium carbonate found in limestone. These bacteria were specifically chosen for being highly resistant in their spore form, capable of surviving in extreme environments such within highly alkaline concrete for long periods of time. When adding these bacterial spores in protective capsules to the concrete, the formation of cracks exposes them to the necessary nutrients needed for them to form calcite that will essentially close up the gaps formed by the cracks. In this case, food is provided in the capsules so the bacteria can grow and calcium is provided because it is needed alongside CO2 in order to form the calcite.

The research focused on by members of the University of Cambridge took a very different route. Although still involving micro capsules,

these were made to contain mineral healing agents. When cracks are formed, the capsules break open and the agents work to seal the cracks before harmful substances like water that reduce the durability of the concrete have the opportunity to enter into the cracks. Sodium silicate is used as an agent because it forms products that are compatible and similar to the cement structure. Despite not being constituted of living beings, this type of self healing concrete is still considered a biomaterial, and still works to keep buildings alive by increasing their life span!

In the research project, four methods of self-healing concrete were tested mainly to see their potential to be used on a large scale and not just in a lab. Considering the nature of the field experiment, all four came out successful for scalability and this is a significant leap in the process of these biomaterials. The impact of these four methods on the strength of the concrete was also analysed and work for its improvement has continued accordingly. It will be only a matter of time before the cement industry becomes incredibly more sustainable.

# Vanilla Made From Plastic Bottles?

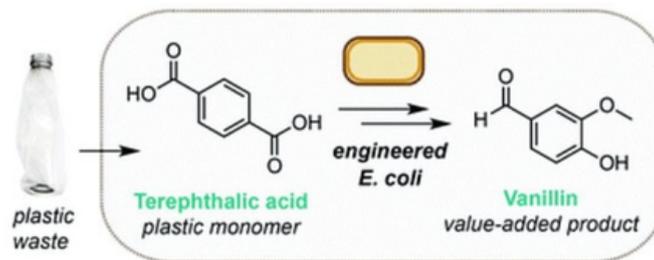
SHRUTHI RAJARAM | BTCZ 3RD YEAR

## Introduction

Plastics have become an irreplaceable part of our lives. Plastics are used for so many things on a daily basis - right from toothbrushes to containers to clothes to mobiles to packaging and so on. Since they are non-biodegradable, plastic disposal becomes a huge issue. Plastics lose 95% of their material value after a single use, which is both economically and environmentally very damaging. This loss means that reusing plastics becomes very difficult and it leads to an estimated \$110 billion loss to the global economy every year. The global plastic crisis is considered to be one of the most pressing issues that requires immediate attention. A life without plastics doesn't seem to be coming anytime soon; hence, new, innovative methods are needed to tackle this problem. One of these methods involves using biotechnology to convert plastics, particularly PET plastics, into vanillin.

## What is PET?

PET stands for Polyethylene Terephthalate. It is used in fabrics, bottles, jars, containers and as a packaging material. Annually, around 50 million tonnes of PET waste is produced globally, drastically exacerbating environmental and economic issues. Current recycling solutions only further contribute to plastic pollution worldwide. Among these, plastic bottles pose a huge problem. They are one of the most polluting single use plastics. About 1 million plastic bottles are sold every minute around the world and only 14% of these are actually recycled.



Credits: [www.pubs.rsc.org](http://www.pubs.rsc.org).

## What is vanillin?

Vanillin is the primary component of the extract of vanilla beans and gives the characteristic taste and smell of vanilla. It's used in the food industry, cosmetics industry, pharmaceutical synthesis, as a cleaning agent, in herbicides, etc. According to a study published in the journal *Green Chemistry*, the global demand for vanillin in 2018 was 37,000 tons and is expected to grow to about 59,000 tons by 2025, generating a revenue of \$734,000,000.

In order to meet the increasing demands of vanillin, methods to synthetically manufacture vanillin have been devised. But these are harmful to the environment as well. Today, about 85% of synthetically produced vanillin is made from eugenol or guaiacol - petrochemicals often derived from crude oil, which is obtained from fossil fuels.

## Vanillin from plastic bottles

Scientists at the University of Edinburgh, Scotland, have come up with a novel biosynthetic pathway that takes place in genetically-engineered *E.coli* cells and converts terephthalic acid - a molecule derived from PET

- into vanillin.

PET is a polymer of terephthalic acid. Hence, PET from plastic bottles is first digested to give terephthalic acid. Terephthalic acid is then converted into vanillin in a 5 step process involving enzymes (biocatalysts) that takes place in the genetically engineered *E. coli* cells.

The scientists initially focused on developing an *in vivo* enzymatic pathway that can directly convert Terephthalic acid into vanillin. *E. coli* has an inherent ability to reduce aldehydes to the corresponding alcohols. Hence, a strain of *E. coli*, called *E. coli* MG1655 RARE was used as the host organism. This strain was previously known to be used for conversion of glucose into vanillin.

The scientists reported a 79% conversion efficiency through this method. Further testing

needs to be done before it can be used for human consumption. This is the first known method in which the end product, vanillin, is obtained directly from PET.

### **Conclusion**

This method of deriving a chemical for human consumption from plastics may seem questionable at first. But, about 85% of vanillin today is manufactured using chemicals from fossil fuels. So, using an approach that can help tackle an enormous problem like the plastic pollution crisis while at the same time producing an important chemical whose demands far exceed its manufacturing potential is advantageous in many ways.

# SUZANNE LEE

DIA SAJI | BTZ 1ST YEAR

Suzanne Lee born in 1970 is a Brooklyn, New York based fashion designer working on fashion and future technologies.

She is a Senior Research Fellow at Central Saint Martin's College of Art and Design, the Director of The BioCouture Research Project and Chief Creative Officer at Modern Meadow.

Her recent Arts and Humanities Research Council (AHRC) funded project BioCouture looks at ecological and sustainability issues surrounding fashion. She is working with scientists to engineer optimized organisms for growing future consumer products. BioCouture is a research project using nature to suggest an innovative future fashion vision. Suzanne Lee uses microbial cellulose composed of millions of tiny bacteria grown in bathtubs of sweet green tea to produce clothing

The idea is to grow a dress in a vat of liquid. BioCouture has been included in Time Magazine's annual roundup of The Top 50 Best Inventions of 2010.

In 2007 she published "**Fashioning the Future: Tomorrow's Wardrobe.**" The book examines the work of the scientific researchers and fashion designers, such as Issey Miyake, Hussein Chalayan, and Walter Van Beirendonck, who are transforming today's science fiction into tomorrow's reality. Lee founded BioFabricate in 2014 to work at the intersection of design, biology and sustainability.



Source: wikipedia.org

*“Microbial cellulose is a fascinating material. From one hugely efficient, single production method, at least three direct products can be obtained: a health drink, a foodstuff and potentially a ‘vegetable’ material. In a process that takes about ten days, the material can be harvested by simply lifting it off the liquid.”*

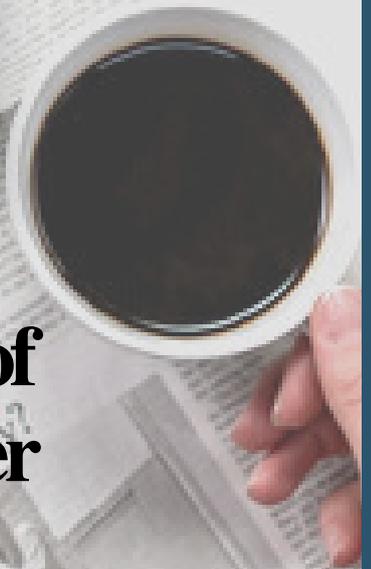
– Suzanne Lee, Founder of BioCouture.

BioCouture envisions future manufacturing systems inevitably consisting of biodesigned living organisms, forming engineered materials directly into finished, biodegradable products, and is focused on that goal. She is working with scientists to engineer optimized organisms for growing future consumer products.

UP NEXT



# NEWS BRIEFING



**The most exciting developments of  
the field in the month of December**

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## Experimental mRNA Vaccine Offers Hope For HIV.

mRNA vaccines' amazing efficacy against COVID-19 has been nothing short of miraculous. The question of whether this technology platform can be applied to the more difficult challenge of generating a vaccine against the human immunodeficiency virus (HIV) is currently being closely examined.

**ANJALI GURAPPA LAMANI | BSC. BTZ 1ST YEAR**

09th December, 2021

*National Institute of Allergy and Infectious Diseases (NIAID), Maryland, USA*

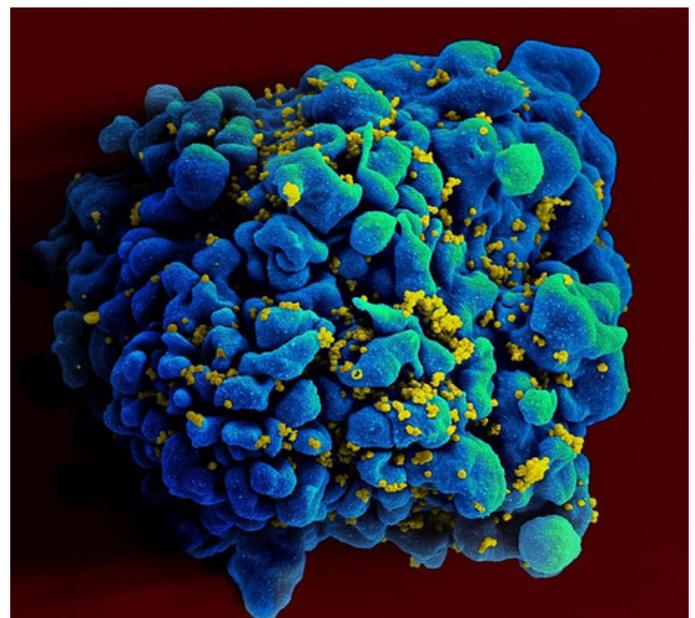
The researchers at NIAID, encapsulated mRNA encoding the HIV envelope glycoprotein, together with the structural HIV group-specific antigen protein, in a lipid nanoparticle, to produce virus-like particles in vivo.

*Rhesus macaques* that received a priming shot followed by multiple boosters had a 79 percent lower per-exposure risk of infection by simian-human immunodeficiency virus (SHIV) compared to unvaccinated animals.

Although the VLPs were not nearly as immunogenic or as efficacious as mRNA vaccines against COVID-19, these results are encouraging and illuminate a pathway toward inducing the higher and more-durable antibody responses needed to prevent infection with HIV.

This is no small feat; Env is a formidable target that fails to induce the right kind of antibodies even in the majority of people who are infected with HIV. Unlike spike protein, which is relatively stable and contains just a few immunodominant epitopes (mostly restricted to the receptor-binding domain). Env is a complex trimeric protein with multiple dispersed antibody epitopes - many of which are conformational and heavily coated in sugars that shield them from antibody attack.

Env proteins through the introduction of key mutations was a major advance in immunogen design, although these so-called 'SOSIP proteins' induced only autologous strain-specific neutralizing antibodies. Instead of carrying mRNA instructions for the coronavirus spike protein, the vaccine delivers coded instructions for making two key HIV proteins, Env and Gag. Antibodies elicited by the Env-Gag mRNA were able to neutralize almost all members of a global panel of HIV isolates, classified as having a tier 2 phenotype.



*Scanning electron micrograph of an HIV-infected H9 T cell*

Credits: [www.nih.gov/](http://www.nih.gov/)

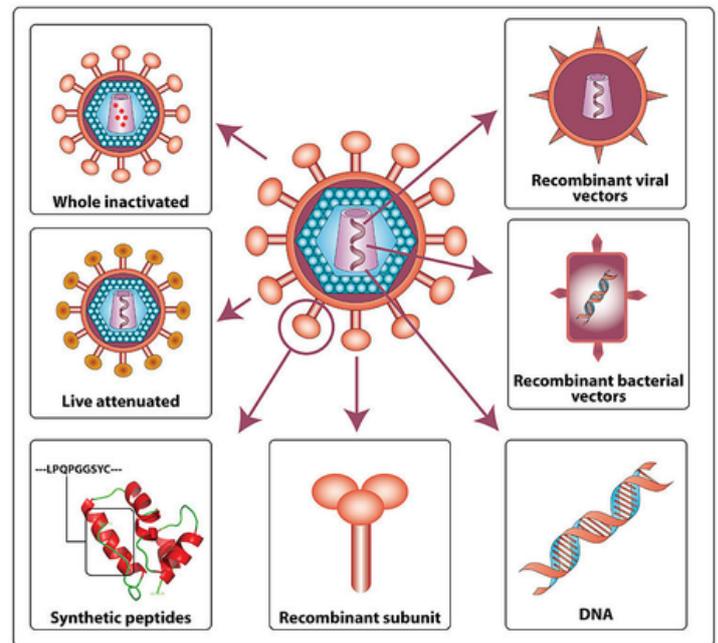
This represents a major step forward for a vaccine against HIV, as this phenotype is typical of most circulating strains, which are difficult to neutralize due to a closed Env conformation. mRNA technology may be uniquely positioned to tackle a major hurdle for HIV vaccines: the elicitation of broadly cross-reactive neutralizing antibodies. A preclinical study takes the first step toward this goal.

mRNA is also considerably cheaper to produce and can be modified as needed, an important consideration for rapidly mutating viruses like HIV. Among the vaccines against COVID-19, those based on the mRNA platform have superior immunogenicity and stimulate both B cell responses and T cell responses.

The vast amount of safety data available from mRNA vaccines against COVID-19 will probably contribute to streamlined regulatory approval processes for vaccines against HIV and other diseases.

In contrast to the swift success of vaccines against COVID-19, the story of the development of vaccines against HIV has been long and troubled.

The hope is that the lessons learned from the development of vaccines against COVID-19 will be used to eradicate HIV and that this will be tackled with the same sense of urgency, given that HIV remains a major global health challenge.



***Various approaches for HIV vaccine development.***

Credits: <https://www.nih.gov/>

## “This treatment could give people with this disease their life back.”

An investigational gene therapy that restores the original shape of the blood cells in sickle cell disease.

AKANKSHA. C. A | BTCZ 3RD YEAR

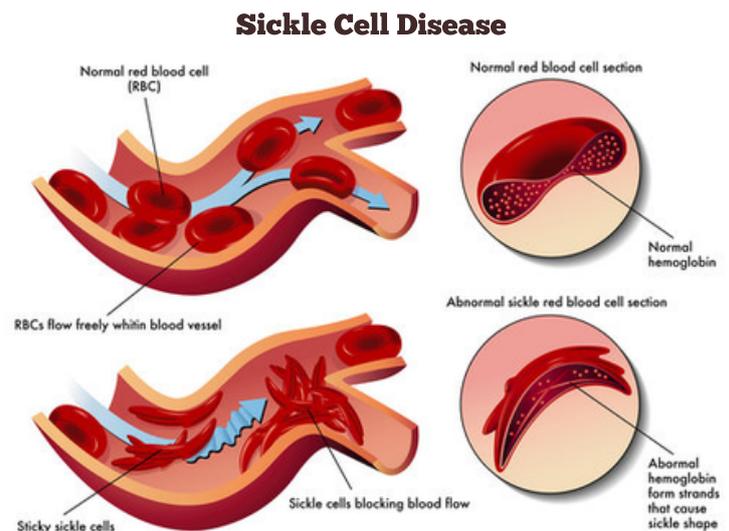
13th December, 2021

Columbia University Irving Medical Centre.

Columbia University Irving Medical Centre is one of the few centres in the world working on clinical trials in gene therapy for sickle cell disease.

Sickle cell disease is caused by mutations in the  $\beta$ -globin chain of haemoglobin which leads to formation of irregularly shaped red blood cells, our oxygen delivering molecules. Due to the mutation, the biconcave shape of normal red blood cells is changed to a sickle shape which causes these cells to stiffen and reduces the efficiency of oxygen transport by the cells. These rigid, sickle-shaped cells often clump together and block capillaries and blood vessels which results in episodes of severe pain and widespread organ damage. This essentially leads to a long list of hospital bills and also reduces the life span of the patient.

In the new gene therapy, called **LentiGlobin**, haemopoietic cells (which are the stem cells in the bone marrow) are collected from the patient's blood and treated with harmless Lentiviruses carrying the modified copy of the  $\beta$ -globin gene which it delivers into the stem cell, which then integrates itself into the genome of the stem cell. The cells are reintroduced into the patient's blood which then mature into healthy, perfectly shaped red blood cells.



Credits: [www.tamingthesru.com](http://www.tamingthesru.com)

*"You cannot overstate the potential impact of this new therapy. People with sickle-cell disease live in constant fear of the next pain crisis. This treatment could give people with this disease their life back."*

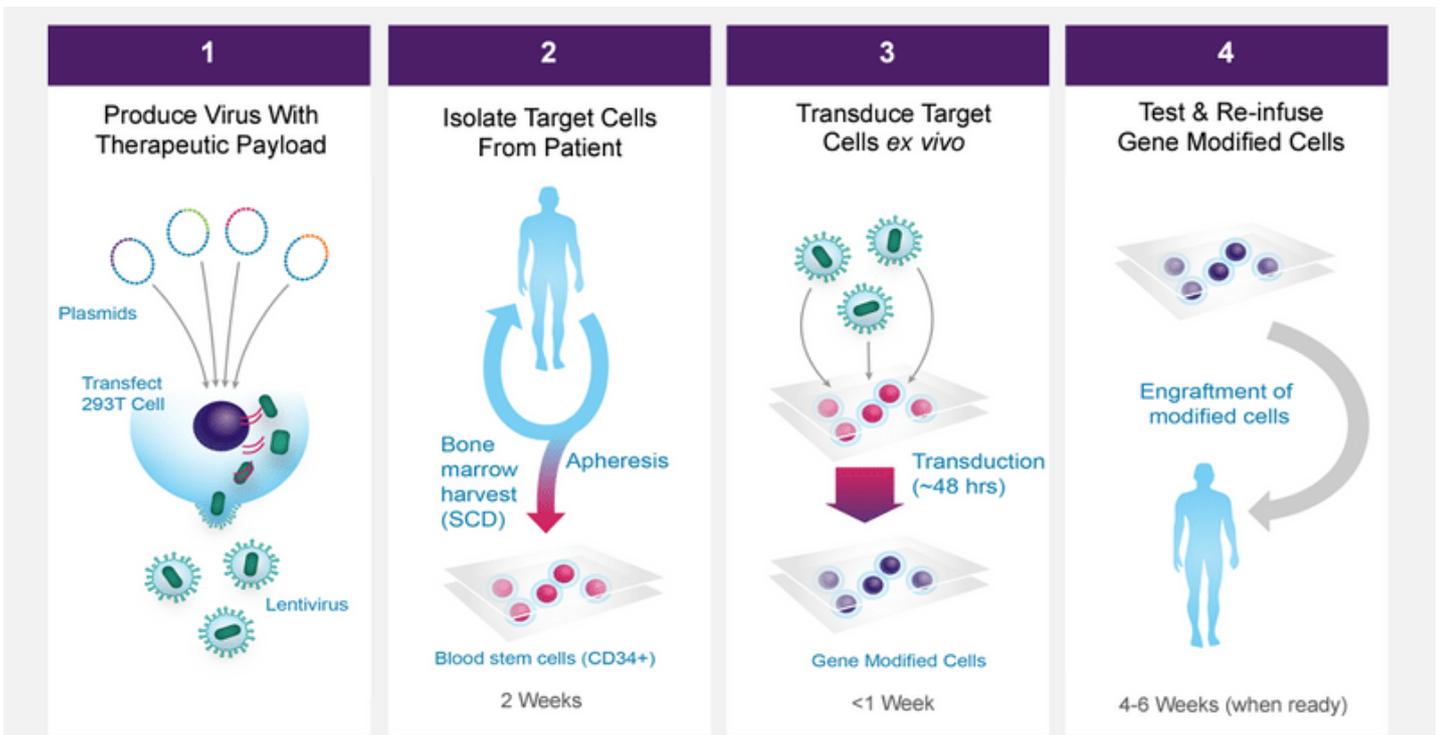
*- said Markus Y. Mapara, MD, PhD, professor of medicine at Columbia University Vagelos College of Physicians and Surgeons and a co-author of the study.*

Usually, the treatment for sickle cell disease is a bone marrow or blood transplant from a closely matched donor but due to the high risk of rejection it is rarely carried out. But with LentiGlobin – the risk of rejection immensely decreases since the therapy uses the patient's own stem cells. The patients participating in the clinical trials reported loss of severe pain after the cell therapy.

With new clinical trials comes limitations and risk factors. In this gene therapy the old, deformed stem cells need to be eliminated from the patient's body to make room for the new re-engineered cells and to stop the production of anymore sickle shaped cells – this process is called **conditioning**. This is carried out by using chemotherapy in high doses, which is toxic and is associated with the risk of cancer.

Two out of thirty-eight patients participating in the clinical trial developed Leukaemia, which is a cancer of body's blood forming tissues. The researchers believe it to be due to the chemotherapy more so than the introduction of re-engineered cells.

Of course, researchers are working towards a less toxic approach to eliminate old stem cells carrying the sickle-cell gene and investigating strategies to make this gene therapy financially accessible.



Credits: [www.wraltechwire.com](http://www.wraltechwire.com)

### *How the gene therapy works*

# Muscle transcriptome provides the first insight into the dynamics of gene expression with progression of age in sheep

Karnataka Veterinary Animal and Fisheries Sciences University, Bangalore and Animal Biotechnology Division, ICAR-National Bureau of Animal Genetic Resources

**B. KAVYA | BTCB 2ND YEAR**

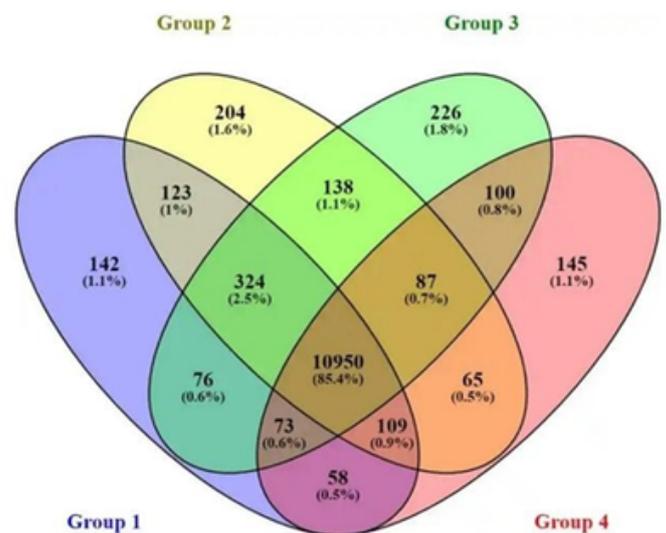
16th November 2021

*BAHS-Basic Animal Husbandry & Fisheries Statistics, Government of India, Ministry of Agriculture, Department of Animal Husbandry, dairying & Fisheries, Krishi Bhavan, New Delhi, 1-132*

The dynamic synergy of genes and pathways in muscles in relation to age affects the muscle characteristics. It is observed that, the gene expression changes in skeletal muscles through successive age groups in Bandur, a meat type sheep of India (famous breed of Karnataka). RNA sequencing data was generated from the longissimus thoracic muscles from four age groups, ranging from lamb to adult. Analysis of 20 highest expressed genes common across the groups revealed muscle protein, phosphorylation, acetylation, metal binding and transport as significant functions. Maximum differentiation was observed after 2.5–3 years on transition from lambs to adult.

Livestock sector plays an important role in the rural economy of India. Several studies have evaluated the impact of age on the tenderness and fatty acid profile of muscles in various species.

Transcriptomic studies have identified regulatory factors involved in muscle growth and meat quality in livestock species. The genetic mechanisms underlying growth and development of skeletal muscles of sheep have been investigated using next generation sequencing techniques.



Distribution of transcripts across four age groups in Bandur sheep. Group 1 = 2 tooth stage or 1 years; Group 2 = 4 tooth stage or 1.5–2yrs; Group 3 = 6 tooth stage or 2.5–3 years; Group 4 = 8 tooth stage or 3.5–4 years.

Credits: [www.nature.com](http://www.nature.com)

*An overall mapping of 94.6% was observed across samples of all age groups. While 79–90% of the reads were uniquely mapped. Comparison of the transcript profile revealed 85.4% transcripts common to all groups. The unique transcripts in each group accounted for only 1–1.8%. The total number of known genes discovered with a minimum threshold of RPKM > 0.01, was 11045, 11168, 10907 and 10514 in group 1, 2, 3 and 4, respectively.*

Differentially expressed genes for contrasting characteristics have been detected in small as well as large ruminants. Such efforts have led to identification of biomarkers for meat quality. Consumer preferences for Bandur sheep in India led to the investigation that established tenderness and higher backfat content in muscles of Bandur sheep as compared to local sheep found in the same area. Our previous studies have attempted to understand the regulatory molecular mechanisms underlying the muscle traits in Bandur sheep breed in comparison to the local sheep. These studies have identified the genes and pathways that may be associated with the muscling traits. Previous studies on goat and pigs have provided some insight on the temporal pattern of expression of genes through developmental stages. However, lack of information on the effect of age on the expression of genes in skeletal muscles of sheep has prompted this investigation.

The aim of the present study was to compare the gene expression pattern in skeletal muscles through successive age groups in Bandur sheep, a meat type breed of India. The temporal changes in gene expression will help illustrate the molecular mechanisms underlying muscle development in sheep.

# Growing Crops in Space? Biotechnology can make this a reality.

The ideal plant for cultivation in space.

**P SHRUSTI SHENOY | BTCZ 1ST YEAR**

14 October, 2021

*Liu, Y., Xie, G., Yang, Q. et al. Biotechnological development of plants for space agriculture.*

If humankind is ever to undertake long-term space missions and colonization, establishing efficient space farming system would be essential for human survival in space. However existing crops are not effective and productive for use on space farms. Hence, a group scientist: Gengxin Xie, Maozhi Ren, Qichang Yang, Yongming Liu, proposed a Whole-Body Edible and Elite Plant (**WBEEP**) strategy for space crop improvement. Relying on plant parts, richer nutrient content, higher yield, and higher mineral nutrient use efficiencies for space farms.

Potato (*Solanum tuberosum L.*) is believed to be one of the top contenders space agriculture due to the following advantages:

- (1) high harvest index and tuber yield and carbohydrate-rich tubers that can provide a large amount of energy for humans
  - (2) simple horticultural and food processing requirements and
  - (3) high tolerance against stresses with the ability to develop normally during spaceflight.
- Importantly, potatoes can be asexually propagated through tubers and sexually propagated through seeds. However, potatoes cannot be efficiently cultivated in space until inherent defects related to their high solanine content, low yield and nutrient accumulation, and low fertilizer use efficiency are overcome.

## **WBEEP strategy for potato improvement that might create a WBEEP-potato for space farming**

**A.** Developing whole-plant edible potatoes. Blocking the biosynthesis of solanine, varying its transcriptional regulation, or introducing other metabolic pathways can reduce the accumulation of solanine and make potato stems, leaves and berries edible.

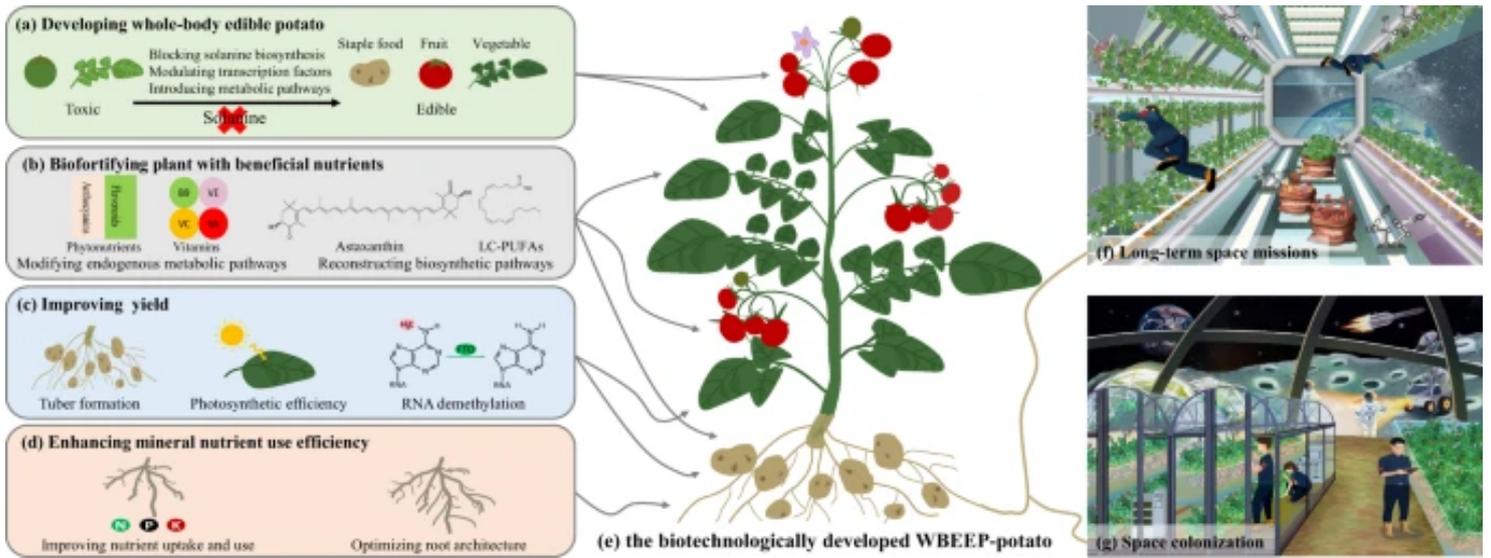
**B.** Biofortifying plants with beneficial nutrients. Biofortification can provide phytonutrients by modifying endogenous metabolic pathways and astaxanthin or VLC-PUFAs (e.g., arachidonic acid) by reconstructing biosynthetic pathways.

**C.** Improving yield. Potato yield can be increased by improving tuberization, photosynthetic efficiency and RNA demethylation.

**D.** Enhancing mineral nutrient using efficiency. Nutrient utilization efficiency can be improved by modulating plant nutrient absorption, allocation and metabolism or optimizing root architecture.

**E.** The biotechnologically developed WBEEP-potato is expected to be applied in long-term space missions.

**G.** Space colonization



Credits: Nature.com

***Biotechnological generation of WBEEP-potato and its applications.***

# Can CRISPR-Cas Help Reduce Climate Change?

Realizing the potential of CRISPR-Cas Technology to mitigate Climate Change.

**SHARON A GABRIELLA | BTCZ 1ST BSC**

1st November 2021

*Vilnius University Institute of Biotechnology*

The manufacturing process can be directed in real-time by understanding the Critical Quality Attributes required for a potent and persistent cell therapy product.

Many sectors and fields of study are looking into new ways to minimise the repercussions of climate change, which are already manifesting themselves as a slew of environmental, social, and economic issues. CRISPR-Cas gene editing has been effectively used in human medicines and diagnostics, and it is now being recognised for its potential to play a key role in mitigating the effects of climate change.

One of the first people to demonstrate programmable DNA cleavage by Cas9 protein was Virginijus Šikšnys, PhD, professor, chief scientist, and head of the Department of Protein–DNA Interactions at the Vilnius University Institute of Biotechnology. His work has helped to turn Lithuania, a Baltic state, into a CRISPR research hotspot. He founded CasZyme in 2017, and the company's research team is presently investigating how CRISPR-Cas molecular tools might be used to address climate change challenges in agriculture and industry. This was emphasised at the Life Sciences Baltics conference, which took place September 20–24.



Credits: Biointeractive.org

In agriculture, plants are continually exposed to new pests and illnesses due to rapidly changing environmental circumstances. Plants can be modified to endure these external forces by becoming more resistant to temperature variations and water scarcity, as well as a variety of diseases. CRISPR-Cas is already being used to create specialised bacteria that can improve the nutritional composition of soil while also altering gas absorption and emissions. This means that some plant cultures will generate less methane and absorb more carbon dioxide as a result of this.

The transportation of food around the world to meet rising demand is one of the key causes of excessive carbon dioxide emissions. If CRISPR-Cas is used to increase plant output, boost food nutritional content, and extend the shelf life of fruits and vegetables, more variety and nutritious food can be produced closer to customers, reducing the need for food transportation.

Food waste contributes significantly to climate change, as up to 45 percent of food is thrown away, resulting in billions of tonnes of CO<sub>2</sub> emissions each year. CRISPR-Cas can help increase the shelf life of our food by strengthening the natural defensive mechanisms of fruits and vegetables, making them more resistant to diseases. This might be used to replace present food preservation technologies that rely on chemicals and high-energy processes.

Furthermore, CRISPR-Cas can aid in the preservation and enhancement of traditional plant species that may be extinct or on the verge of extinction due to climate changes in areas where they have been grown for decades.

This could lead to more environmentally friendly and socially responsible agricultural and food production, as well as the preservation of traditional businesses like winemaking.

CasZyme's mission is to address the demands of its clients from many industries by identifying Cas proteins that may be used not only in human medicines and diagnostics, but also in agriculture, the food industry, and industrial biotech enterprises. The CasZyme example demonstrates how the same molecular tools generated using CRISPR-Cas gene editing technology may be used to treat a variety of global challenges ranging from the most severe human diseases to climate change. Most CRISPR-Cas activities in agriculture are still in the early stages of development, and tight collaboration between scientists, the research community, and industry is required to accomplish even more extensive application of CRISPR-Cas technology for climate change-related challenges.

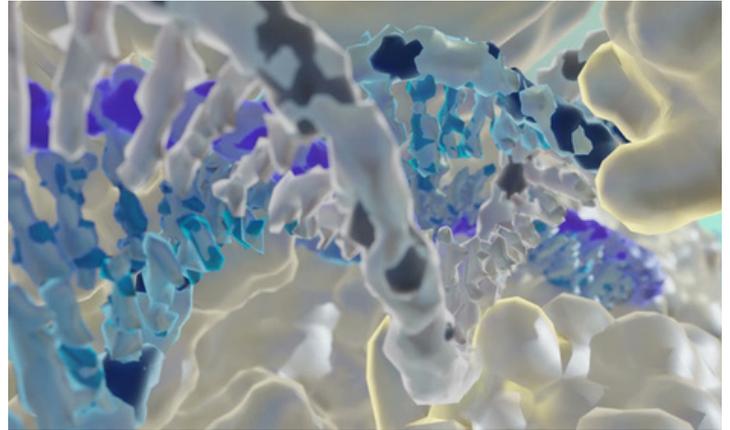
# New Biosensors Shine Light On CRISPR Gene Editing.

NIKHILA MOHAN | BTCZ 2ND YEAR

9th December, 2021

*Department of Energy's Oak Ridge National Laboratory*

CRISPR technologies are currently the primary tools of bioengineering, and new versions are continually in development. Identifying whether an organism has been modified by CRISPR technology was previously a complex and time-consuming process and the only way to identify this was to do forensic analysis. The research team developed an efficient self-detect solution that takes advantage of the way CRISPR works to trigger the technology to reveal itself. Under normal conditions, CRISPR works by connecting with a short RNA sequence, known as the guide RNA, as it leads CRISPR to a matching DNA sequence. When the target DNA is found, CRISPR modifies the DNA by acting like tiny molecular scissors to cut through one or both strands of DNA, depending on the type of CRISPR technology in use. This method can be linked with an alarm system having two components, a biosensor guide RNA that redirects CRISPR activity and a reporter protein that flags the activity. Researchers encode the two components into an organism's DNA to enable the monitoring system. With the self-detect system in place, the biosensor guide RNA intercepts CRISPR, preventing CRISPR from connecting with its original gene target and redirecting CRISPR to a specific DNA sequence that encodes for a non-functioning green fluorescent protein, or GFP.



Credits: Oakridge national laboratory

When CRISPR edits the sequence, it flips a switch that produces functioning GFP, which creates a green glow signalling CRISPR's presence. Researchers developed a new protein called **eYGFPuv**, that is visible under the type of ultraviolet light commonly known as a black light. This prevents the use of microscope to see the glow of the GFP.

Now its possible to see whether CRISPR is active in real time regardless of the size, shape and location of the organisms being evaluated. Since CRISPR must be tailored to each organism for effective use, knowing whether the CRISPR technology is working in a particular plant or microbe can accelerate progress toward goals such as developing drought-resistant bioenergy crops and engineering bacteria to efficiently convert plants into sustainable aviation fuels.

Now its possible to see whether CRISPR is active in real time regardless of the size, shape and location of the organisms being evaluated. Since CRISPR must be tailored to each organism for effective use, knowing whether the CRISPR technology is working in a particular plant or microbe can accelerate progress toward goals such as developing drought-resistant bioenergy crops and engineering bacteria to efficiently convert plants into sustainable aviation fuels. The research team created specific biosensors to detect various CRISPR tools, including Cas9 nuclease, prime editor, base editor and CRISPR. They demonstrated the sensors individually with each sensor signalling the presence of a particular type of CRISPR tool. Abraham also sees the potential to combine the biosensors into a version that would flag multiple gene editing technologies at once.

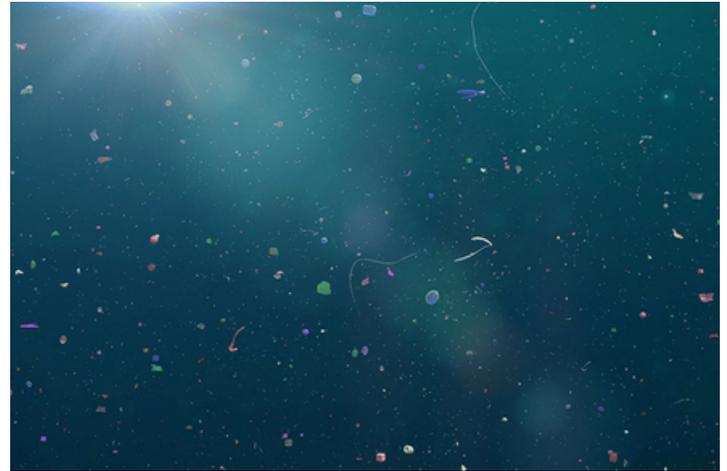
# Effect of micro-plastic on human health : the known and the unknown

RACHAEL SHARON.H | BTCB 3RD YEAR & KAREN JOHN | BTCB 3RD YEAR

20th December, 2021

*American Chemical Society*

A researcher, Charles Rolsky says "You can find plastics contaminating the environment at virtually every location on the globe, and in a few short decades, we've gone from seeing plastic as a wonderful benefit to considering it a threat, there's evidence that plastic is making its way into our bodies, but very few studies have looked for it there. And at this point, we don't know whether this plastic is just a nuisance or whether it represents major human health hazards. Micro plastics are defined as plastic fragments less than 5 mm, or about 0.2 inches, in diameter. Nanoplastics are even smaller, with diameters less than 0.001 mm. Leading research in wildlife and animal models has connected micro- and Nano plastic exposure to infertility, inflammation and cancer, but health hazard in humans are not been studied properly. Previous studies have shown that plastics can pass through the human gastrointestinal tract, but Rolsky and his partner Varun Kalka from the Arizona State University, wondered if the tiny particles accumulate in human organs too. To find out more about this study , collaboration were made with other researchers and samples from a large repository of brain and body tissues that was established to study neurodegenerative diseases, such as Alzheimer's was obtained. The 47 samples were taken from lungs, liver, spleen and kidneys -- four organs likely to be exposed to, filter or collect microplastics.



Credits: youmatter.world

A procedure was developed to extract plastics from the samples and analyse them by Raman spectrometry. The researchers also created a computer program that converted information on plastic particle count into units of mass and surface area. They say that this , which will be shared as a tool online, will help build a plastic exposure database so that researchers can compare exposures in organs and groups of people over time and geographic space. The method will help researchers to detect dozens of types of plastic components within human tissues, including polycarbonate (PC), polyethylene terephthalate (PET) and polyethylene (PE). When paired with a previously developed mass spectrometry assay, plastic contamination was detected in every sample. Bisphenol A (BPA), still used in many food containers despite health concerns, was found in all 47 human samples.

To the researchers knowledge, this study is the first to examine micro- and nanoplastic occurrence in human organs from individuals with a known history of environmental exposure. "The tissue donors provided detailed information on their lifestyle, diet and occupational exposures. Because these donors have such well-defined histories, our study provides the first clues on potential micro- and nanoplastic exposure sources and routes," Dr Halden , a scientist from Arizona State University. Should people be concerned about the high detection frequency of plastic components in human tissues?

We never want to alarm people, but it is concerning that these non-biodegradable materials that are present everywhere can enter and accumulate in human tissues, and the possible health effects have not been studied properly, “ Kelkar says. "Once we get a better idea of what's in the tissues, we can conduct epidemiological studies to assess human health outcomes. That way, we can start to understand the potential health risks, if any." We are being choked to the death by the amount of plastic we throw away. There are more micro plastics in the ocean than the stars in the sky. It is killing our ocean and entering into our bodies, creating health hazards. What we do makes a difference but we have to decide what kind of difference we want to make .

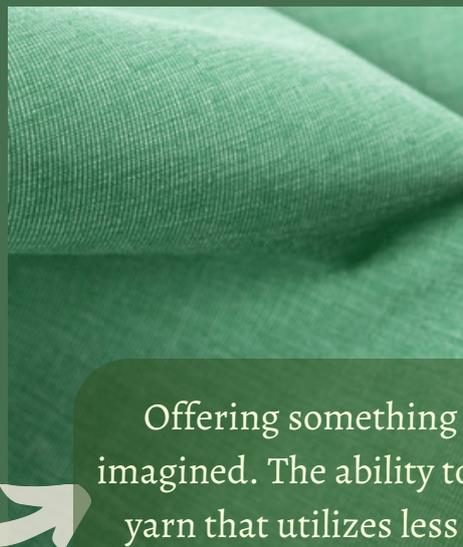
# SUSTAINABLE INNOVATIONS

AKANKSHA. C. A | BTCZ 3RD YEAR

## "The Veganbottle"

An All-Natural Alternative to Plastic Bottles

Derived completely by using sugarcane biomass and biodegradable materials, this wonderful plant-based bottle is easily compostable and helps eliminate one of the major reasons of water pollution; plastic.



## "S.Café"

Fabric created with recycled coffee grounds

Offering something beyond what anyone would've imagined. The ability to turn tiny coffee grounds into yarn that utilizes less energy, less temperature, and drying 200% faster compared to cotton. It also provides protection against the sun's ultraviolet radiation and absorbs odours.

# Little helpers

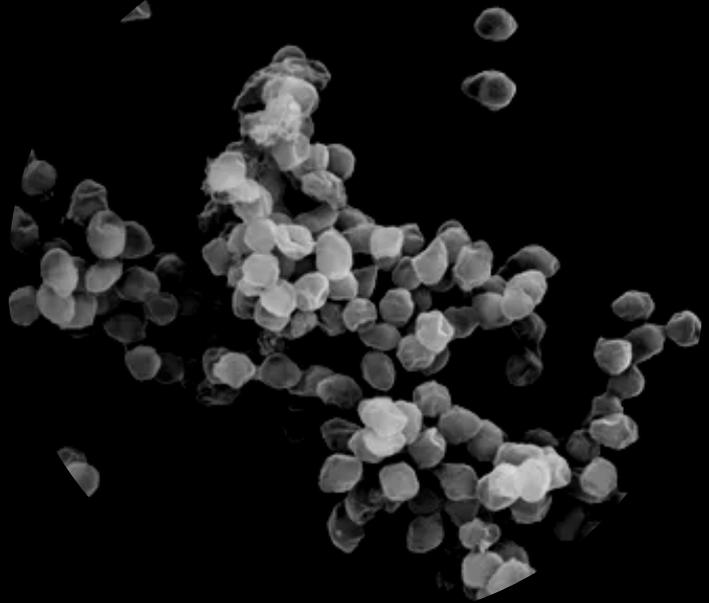
AKANKSHA. C. A | BTCZ 3RD YEAR

## *Rhodovulum sulfidophilum*

Electricity-eating bacteria a.k.a  
Photoferrotrophs, that could help fight  
climate change.

According to Arpitha Bose, lead microbiologist at Washington University, these bacteria are common and found in marine sediments, they propose a future to combating climate change.

They make a massive contribution to carbon dioxide fixation, which means they can take in and utilize excessive amounts of the greenhouse gas and relatively reduce its concentration in the surrounding environment,

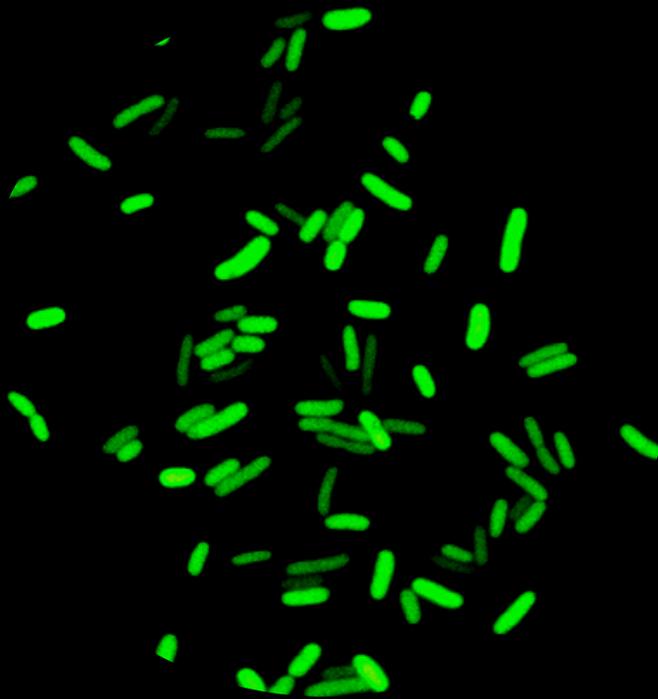


Scanning electron micrographs of *Rhodovulum sulfidophilum* bacteria.

CREDIT: ARPITA BOSE AND RAJESH SINGH

## *Escherichia coli*

Fluorescent bacteria that detects  
explosives.



Green fluorescent *E-coli*

CREDITS: DENNIS KUNKEL MICROSCOPY/SCIENCE SOURCE

Scientists from Edinburgh University have genetically modified a harmless strain of *E. coli* into glowing green in the presence of certain explosives. The modified bacteria produces a protein that glows green upon detection of DNT, a by-product of TNT, which is found in many landmines. This reaction then 'switches on' a gene that creates luciferase, an enzyme *E-coli* to emit light.

This is a good alternative to using metal detectors and animals for detection of mines.

# Little helpers

AKANKSHA. C. A | BTCZ 3RD YEAR

## *Magnetococcus marinus*

A bacteria that uses magnetic fields to target tumours to deliver drugs.

These aquatic bacteria use the earth's magnetic field to direct themselves at the ocean depths and they just so happen to prefer low oxygen levels.

The researchers at McGill University in Canada used these properties of this particular bacteria to their advantage, they loaded the bacteria with liposomes containing anti-cancer drugs and guided it towards a tumour using a magnetic field. Once the bacteria made it inside the tumour, the field was turned off and the bacteria was allowed to enter the oxygen-depleted centre of the tumour, where it releases the drug thus, destroying the tumour.

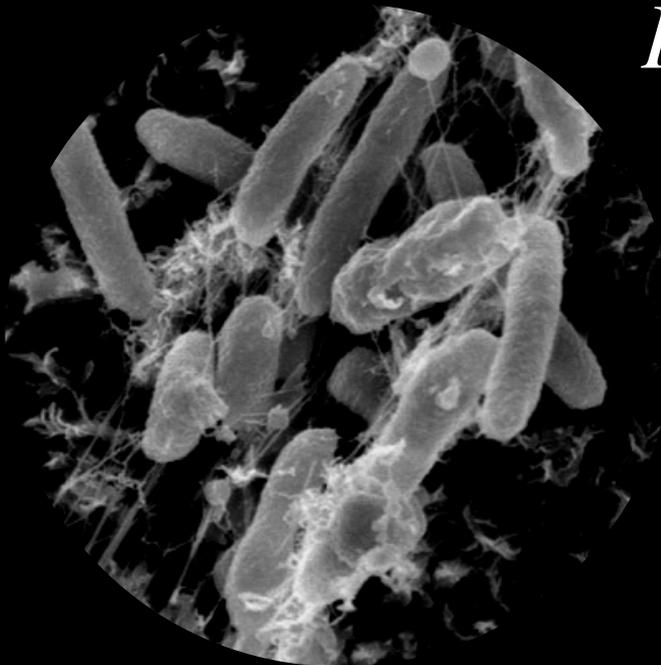


A scanning electron microscopy image of a *Magnetococcus marinus* bacterium, carrying liposome bubbles filled with an anti-cancer drug on its surface

CREDITS: NATURE PUBLISHING GROUP

## *Ideonella sakaiensis*

A bacteria that evolved only 80 years ago, produces enzymes that can degrade plastic.



*Ideonella sakaiensis* binds to plastic by making sticky threads, which it uses to glue itself down

CREDITS: ARTIS MICROPIA

Japanese researchers, Dr. Kohei Oda from the Kyoto Institute of Technology and Dr. Kenji Miyamoto from Keio University have discovered a bacterium that breaks down PET (polyethylene terephthalate) which is widely used in the manufacture of plastic bottles and packaging. This bacterial species secretes enzymes that digest the polymer into an intermediate substance, which it can then easily absorb.

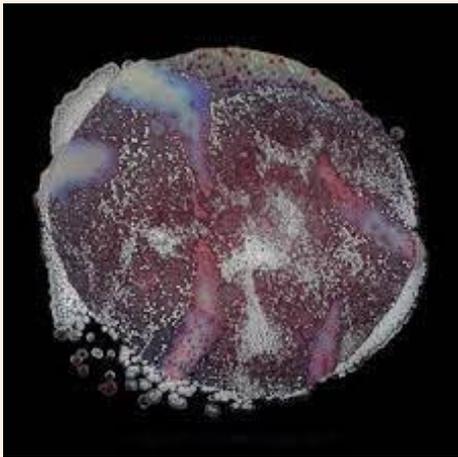
It takes it about 6 weeks, at a temperature of 30°C, to break down the polymer. Researchers are looking at enhancing the rate of degradation and adjusting the temperature sensitivity of the bacteria.

# SUSTAINABLE BIOTECHNOLOGY

As biotechnological research picks up pace with every passing day, scientists are able to give us these novel advancements that are sustainable and environment-friendly, to replace many items and practices in daily use that are detrimental to the environment.

**SHRUTHI RAJARAM | BTCZ 3RD YEAR**

**1.** 'Fast fashion' is an extremely polluting industry and one of the major contributors to this is the dyes used to give color to fabric. Attempts made to use biological alternatives have resulted in an amazing alternative to synthetic dyes - using bacteria! Bacteria grown on dishes can have various colors. These colors are due to pigments in the bacteria. These pigments are used to dye fabrics.



**A small piece of fabric fit for a petri dish and dyed by *S. coelicolor*.**

Image credit - [www.asm.org](http://www.asm.org)



**SILK SHIBORI  
Dyed with *Janthinobacterium lividum***

This particular fabric dye has been made by the company Kukka under its biodesign research project - 'Living color' - exploring the possibilities of natural and sustainable textile dyeing with pigment producing bacteria.

Image credit - [www.kukka.nl](http://www.kukka.nl)

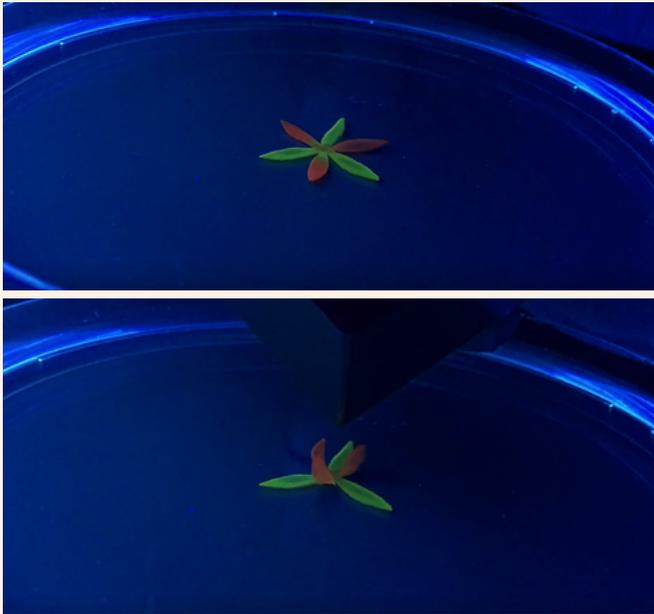
**2.** Plastics are extremely bad for the environment, their primary effect being that they are non biodegradable. DNA plastics on the other hand - a much better, safer option. Professor Dan Luo and his team from Cornell University observed that after isolation, DNA can be made into materials that are pliable at -20 degree Celsius.



**Looks like an art and craft papier mache cup, doesn't it? Well, it's not. This is a cup made from the same chemicals that make us - DNA!**

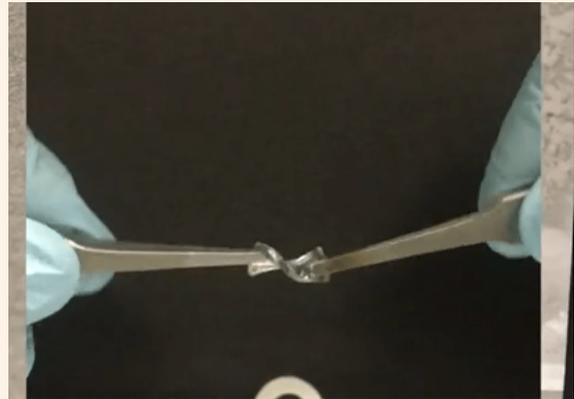
Image credit - [www.newscientist.com](http://www.newscientist.com)

**Pictures showing pliability of DNA which makes it a suitable replacement to plastics :-**



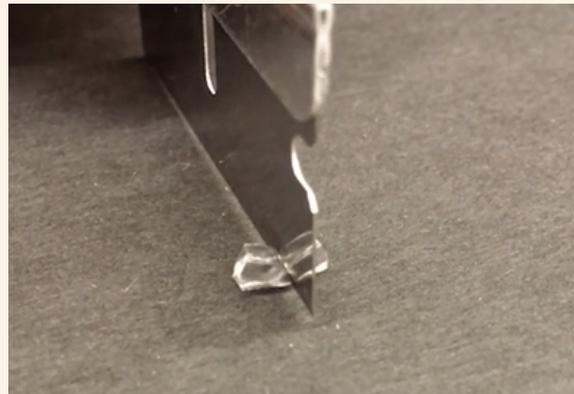
**DNA made into a magnetic material, attracted by the magnet**

*Image credit - CornellCALs*



**DNA material resistant to twisting**

*Image credit - CornellCALs*



**DNA material resistant to pressure**

*Image credit - CornellCALs*

**3.**

Vegan glitter - Ordinary glitter is included in many things, the most common being cosmetics products. It is made from very minute particles of plastic and aluminium which makes cleaning them also difficult. Vegan glitter, developed by a team in University of Cambridge, is glitter made from 'colloidal particles of cellulose nanocrystals' obtained from the cellulose found in plants.



**This image shows 3 vials containing the same CNC particles but in 3 different solvents - pure water, water and ethanol mixture, pure ethanol. The difference in color is due to the ability of water to swell the structure of these particles. The exact color depends on the water content within the particles.**

*Image credit - Photographed by Benjamin Droguet*

4.

Leather production processes are environmentally unsustainable. To combat this, Pinatex, founded by Dr. Carmen Hijosa, came up with the idea of making leather using the fibre extract of pineapples. The fibres are combined with PLA and petroleum based resins. The resulting leather is softer and more pliable than traditional leather. Since it still uses plastics, it's not completely biodegradable but it offers a much better alternative to using cowhides.



**1.Extraction of the fibres from pineapple leaves**

*Image credit - Piñatex (ananas-anam.com)*



**2.Washing and drying the fibres**

*Image credit - Piñatex (ananas-anam.com)*



**3.Fibres after purification**

*Image credit - Piñatex (ananas-anam.com)*



**4.A few processes later - the end products**

*Image credit - Piñatex (ananas-anam.com)*

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*Thank you for reading!  
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